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Range Commanders Council

RANGE SAFETY GROUP

DOCUMENT 308-93

RANGE SAFETY TRANSPONDER CATALOG

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KWAJALEIN MISSILE RANGE
YUMA PROVING GROUND
DUGWAY PROVING GROUND
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FOREWORD

This catalog provides reference information on radar tracking transponders used to support range-safety functions at the DOD and NASA test ranges and facilities. The information contained in this publication is taken from manufacturer supplied specifications and is provided as reference material only. Inclusion of hardware in this catalog does not constitute approval or endorsement for use at any government installation. Use of a specific transponder at a test range or facility must be approved by the installation commander or designated representative.

Note that the current "G-band" and the old "C-band" designations are synonymous. Likewise, the current "I-band" and the old "X-band" are synonymous.

TABLE OF CONTENTS

LIST OF FIGURES

V E G A

Figure Number

H E R L E Y

1. VEGA PRECISION LABORATORIES, INC.
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VIENNA, VIRGINIA 22180-4994
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G-BAND RADAR TRACKING TRANSPONDERS

Model 302C-26
Model 355C-4
Model 369C
Model RT374C-1
Model 380C
Model RT385
Model 6156-1

VEGA PRECISION LABORATORIES
G-BAND NONCOHERENT RADAR TRACKING TRANSPONDER

Manufacturer's Model Designation:	**302C-26**
Manufacturer's Part Number:	**408407-1**
Military Designation:	**Not assigned**
Federal Stock Number:	**Not assigned**

1.0 GENERAL DESCRIPTION

The model 302C-26 C-Band Radar Transponder is a medium power unit used in conjunction with tracking radars and offers test-range users a low-cost approach to tracking airborne vehicles.

This unit features a front-panel decode switch to select the interrogation pulse code spacing in 1 microsecond increments providing for rapid selection of mission code parameters. It has modular construction for ease of repair. The model 302C-26 is interchangeable in weight, outline, footprint, and electrical interface with the model 302C-2 transponder.

2.0 DEVELOPMENT AND UTILIZATION

This unit was developed by Vega using company funds.

3.0 TECHNICAL SPECIFICATIONS

3.1 General Characteristics

3.1.1 Frequency Range: 5.4 to 5.9 GHz

3.1.2 Trigger Sensitivity: -70 dBm minimum

3.1.3 Peak Power Output: 400 watts minimum

3.1.4 Standard Reply Delay: 2.0 to 6.0 microseconds adjustable

3.1.5 Interrogation Pulse Coding: Single or double pulse, front panel switch selectable

3.1.6 Pulse Repetition Frequency Response Range: 10 to 2600 pps

3.1.7 Recovery Time: 50 microseconds maximum

3.1.8 Nominal Operating Voltage: 22 to 32 Vdc

3.1.9 Operating Stabilization Time: 3 minutes

3.2 **Receiver/Decoder Characteristics**

3.2.1 Design Type: Superheterodyne

3.2.2 Frequency Range: 5.4 to 5.9 GHz

3.2.3 Receiver Tuning: Single local oscillator tuning control and three preselector tuning controls accessible from exterior of unit

3.2.4 Frequency Stability: ±2 MHz after 3 minute warmup

3.2.5 3 dB Bandwidth: 11 ±3 MHz

3.2.6 40 dB Bandwidth: 90 MHz typical

3.2.7 Off-Frequency and Image Rejection: Image rejection 60 dB minimum

3.2.8 Dynamic Signal Range: +20 to -70 dBm

3.2.9 Maximum Input Signal: +20 dBm

3.2.10 Pulse Width Acceptance: 0.25 to 5.0 microseconds, single pulse. 0.25 to 1.0 microseconds, double pulse

3.2.11 Pulse Rise Time Acceptance: 0.1 microsecond or less

3.2.12 Pulse Code Spacing: 3.0 to 12.0 microseconds, front panel switch selectable

3.2.13 Decoder Accept Limits: ±0.15 microsecond

3.2.14 Decoder Reject Limits: ±0.30 microsecond

3.2.15 Delay Decision Pulse Trigger Point (Percent of rise time): Not specified

3.3 **Transmitter Characteristics**

3.3.1 Design Type: Magnetron

3.3.2 Frequency Range: 5.4 to 5.9 GHz

3.3.3 Transmitter Tuning: Single control accessible from exterior of unit

3.3.4 Frequency Stability: ±3.0 MHz under all conditions except temperature. During changes in ambient temperature frequency drift will not exceed 50 KHZ/°C (27.8 KHz/)

3.3.5 Peak Power Output: 400 watts minimum

3.3.6 Power Spectrum: The RF bandwidth in MHz will not exceed 3.0/pulse width in microseconds measured at the quarter power point.

3.3.7 Spectral Purity: Not specified

3.3.8 Spurious Radiation: Not specified

3.3.9 Pulse Repetition Rate Range: 10 to 2600 pulses per second

3.3.10 Duty Cycle: 0.002 maximum

3.3.11 Pulse Width: 0.5 ±0.1 microsecond

3.3.12 Pulse Width Jitter: 0.01 microsecond maximum

3.3.13 Pulse Amplitude Variation: Not specified

3.3.14 Pulse Rise Time (10 to 90 percent): 0.1 microsecond maximum

3.3.15 Pulse Fall Time (90 to 10 percent): 0.2 microsecond maximum

3.4 **Delay Characteristics**

3.4.1 Absolute System Delay Variation: Not specified

3.4.2 Reply Delay Variations

3.4.2.1 Signal Strength Variation: ±0.05 microsecond from 0 to -65 dBm

3.4.2.2 Interrogation Rate Variation: Not specified

3.4.2.3 Interrogation Frequency variation: Not specified

3.4.2.4 Pulse Code Spacing Variation: Not specified

3.4.2.5 Decision Pulse Rise Time Variation: Not specified

3.4.2.6 Input Power Potential Variation: Not specified

3.4.2.7 Acceleration Variation: Not specified

3.4.3 Reply Delay Jitter: ±0.05 microsecond at an input signal level of -55 to -65 dBm. ±0.02 microsecond at input signal level of 0 to -55 dBm

3.5 **Radio Frequency Load Matching Characteristics**

3.5.1 Input Impedance: 50 ohm nominal

3.5.2 Output Impedance: 50 ohm nominal

3.5.3 Open/Short Survival: Transmitter shall meet all requirements after application and removal of either a short or open circuit at the antenna terminal.

3.5.4 Voltage Standing Wave Ratio of Load: Will operate in conjunction with an antenna system having a VSWR of 2:1 at all phase angles.

3.5.5 Duplexer Type: Four-port ferrite circulator

3.6 **Power Supply Characteristics**

3.6.1 Design Type: Primary regulated dc-dc converter

3.6.2 Input Voltage Range: 22 to 32 Vdc

3.6.3 Under Voltage/Over Voltage Protection: Not specified

3.6.4 Input Current, Quiescent: 0.9 ampere maximum

3.6.5 Input Current, Interrogated at 1000 pulses per second: 1.1 ampere at 28 Vdc

3.6.6 Transient Protection: MIL-E-26144

3.6.7 Grounding and Isolation: Input power lines isolated from chassis ground

3.6.8 Standby Operation: Same as quiescent

3.7 **Design Characteristics**

3.7.1 Response to Valid Interrogations: Shall trigger at least 99 percent replies to signals at level between 0 to -70 dBm applied to the transponder antenna connector

3.7.2 Random Triggering: Will not exceed 10 pulses per second under any operating conditions

3.7.3 Transmitter-Receiver Frequency Separation: 50 MHz minimum

3.7.4 Off-Band Rejection Filter: Three-section preselector and tuned IF amplifier

3.7.5 Mixer Diode Protection: Preselector protects diode from off frequency RF.

3.7.6 Power Delay Time: 3 minutes

3.7.7 Reverse Polarity Protection: Provided on 28 Vdc line

3.7.8 Over-Interrogation Protection: Provided to limit transmitter duty cycle to 0.002

3.7.9 Lock-Out Protection: Provides for no response during microsecond recovery time of transponder

3.8 **Environmental Specifications**

3.8.1 Operating Temperature: -54°C to +75°C (-65°F to +167°F)

3.8.2 Nonoperating Temperature: -62°C to +75°C (-80°F to +167°F)

3.8.3 Pressure Altitude: 760 mm of mercury to 0.04 mm of mercury (230,000 feet altitude)

3.8.4 Shock: 125g in any direction, 3 shocks in opposite directions along each axis for 6 milliseconds

3.8.5 Sine Vibration: 5 to 25 hz, 0.4 inch double amplitude, 2 to 2500 hz, 15g

3.8.6 Random Vibration: 0.0009 G^2 rms/Hz up to 150 Hz, increase to 0.2 G^2 rms/Hz, from 600 to 800 Hz, decrease to 0.02 G^2 rms/Hz at 2000 Hz

3.8.7 Acoustical Noise: Not specified

3.8.8 Random Noise: Not specified

3.8.9 Acceleration: 125g applied along any axis for 3 minutes

3.8.10 Humidity: Any, up to 100 percent including condensation because of temperature change

3.8.11 Salt Fog Atmosphere: Not specified

3.8.12 Rain: Not specified

3.8.13 Sand and Dust: Not specified

3.8.14 Fungus: Not specified

3.8.15 Missile Fuel Compatibility: Not specified

3.8.16 Electromagnetic Compatibility: MIL-STD-461A

3.9 **Physical/Mechanical Characteristics**

3.9.1 Form: Rectangular solid

3.9.2 Dimensions, Excluding Protrusions: 4.27 x 4.68 x 2.26 inches

3.9.3 Displacement Volume: 43 cubic inches

3.9.4 Weight: 45 ounces maximum

3.9.5 Pressurization: Not specified

3.9.6 Mounting Attitude: Any

3.9.7 Mounting Dimensions: 6 holes 0.173 diameter, 1 hole on centerline front and rear spaced 4.69 inches apart. 1 hole 1.84 inches either side of centerline front and rear.

3.9.8 Power and Test Connector: MS3114H8C-4P (mates with MS3116E8-4S)

3.9.9 Radio Frequency Connector: TNC female

3.9.10 Type of External Controls: None

3.9.11 Pressurization Fitting Type: Schraeder type with protective cap

3.9.12 Grounding and Bonding: Not necessary

3.9.13 Mounting Bracket: Not specified

3.9.14 Mounting Type: Not specified

3.10 **Auxiliary Functions**

3.10.1 External Output Signal Provisions: A pulsed video signal from the decoder output (Telemetry Output)

3.10.2 External Input Signal Provisions: A trigger input for externally triggering the transmitter (Telemetry Input)

3.10.3 External Adjustments: Transmitter tuning, receiver tuning, sensitivity, decoder, and delay

3.10.4 External Test Points: A pulse video signal equivalent to the decoder input signal which is indicative of the received signal. A gate pulse which is indicative of the decoder gate setting.

3.10.5 Internal Test Points: Provided to allow rapid isolation of malfunction to a particular module

3.11 **Coherent Velocity Specifications**

3.11.1 Pulse Coherence Doppler Error: Not applicable

3.11.2 Dynamic Signal Strength Range: Not applicable

3.11.3 Spectral Skew: Not applicable

3.11.4 Carrier Line Width: Not applicable

3.11.5 Interline Noise: Not applicable

3.11.6 Frequency Locking Range: Not applicable

4.0 **QUALITY/RELIABILITY DATA**

4.1 **Reliability Characteristics**

4.1.1 Design Reliability: Not specified

4.1.2 Operational Stability: Not specified

4.1.3 Service Life: Unlimited, with proper maintenance and replacement of parts

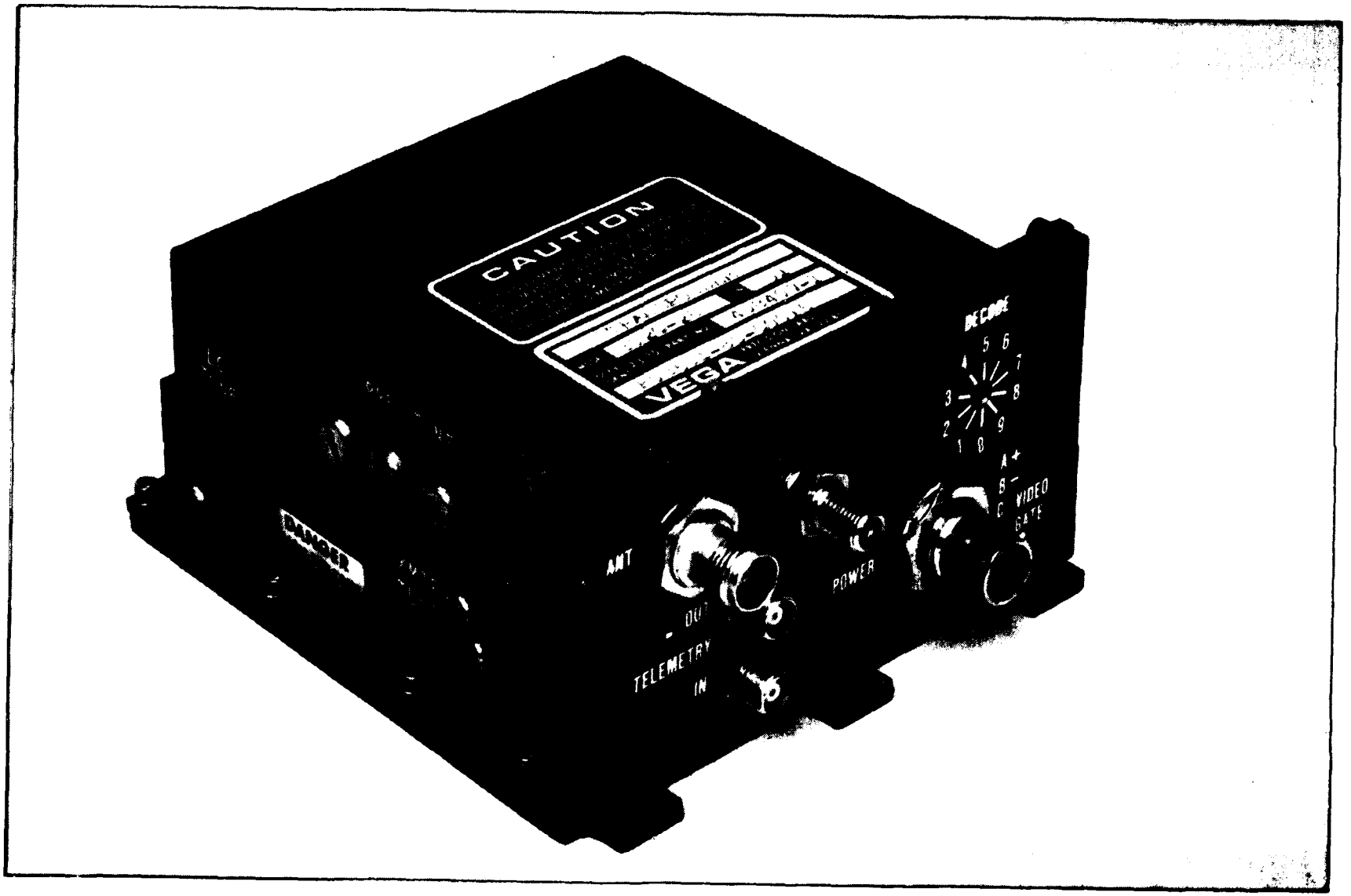

Figure 1-1. Model 302C-26 C-Band Radar Transponder.

VEGA PRECISION LABORATORIES
G-BAND COHERENT RADAR TRACKING TRANSPONDER

Manufacturer's Model Designation:	**355C-4**
Manufacturer's Part Number:	**409486-1**
Military Designation:	**Not assigned**
Federal Stock Number:	**Not assigned**

1.0 GENERAL DESCRIPTION

The model 355C-4 is an extremely compact G-band pulse-coherent radar transponder designed for use with G-band tracking radars that extract doppler information from the transponder return pulse. The unit is designed for satellite and missile applications where precise range, velocity, and acceleration measurements are required and low current drain is necessary. The model 355C-4 is compatible with the AN/FPS-16, AN/TPQ-18, and AN/FPQ-6 radars modified for coherent operation (using coherent signal processing) and may be used in a noncoherent mode with unmodified radars.

2.0 DEVELOPMENT AND UTILIZATION

This unit was developed by Vega under contract for the Minuteman III Program.

3.0 TECHNICAL SPECIFICATIONS

3.1 General Characteristics

3.1.1 Frequency Range: Fixed within the range of 5.4 to 5.9 GHz by replacement of modules

3.1.2 Trigger Sensitivity: -73 dBm minimum

3.1.3 Peak Power Output: 200 watts typical

3.1.4 Standard Reply Delay: 2.5 ±0.1 microsecond

3.1.5 Interrogation Pulse Coding: Double pulse

3.1.6 Pulse Repetition Frequency Response Range: 100 to 2600 pps

3.1.7 Recovery Time: 50 microseconds maximum

3.1.8 Nominal Operating Voltage: 24 to 32 Vdc

3.1.9 Operating Stabilization Time: 3 minutes

3.2 **Receiver/Decoder Characteristics**

3.2.1 Design Type: Superheterodyne

3.2.2 Frequency Range: Fixed within the range of 5.4 to 5.9 GHz by replacement of modules

3.2.3 Receiver Tuning: Factory adjustment only

3.2.4 Frequency Stability: ±3 MHz, after 3 minute warmup

3.2.5 3 dB Bandwidth: 11 ±3 MHz

3.2.6 40 dB Bandwidth: 45 MHz typical

3.2.7 Off-Frequency and Image Rejection: Image rejection, 60 dBm minimum

3.2.8 Dynamic Signal Range: 0 to -73 dBm

3.2.9 Maximum Input Signal: -10 dBm

3.2.10 Pulse Width Acceptance: 0.25 to 1.0 microseconds

3.2.11 Pulse Rise Time Acceptance: 0.05 microsecond or less

3.2.12 Pulse Code Spacing: 3.0 to 9.0 microseconds selectable

3.2.13 Decoder Accept Limits: ±0.15 microsecond

3.2.14 Decoder Reject Limits: ±0.30 microsecond

3.2.15 Delay Decision Pulse Trigger Point (Percent of rise time): 80 percent typical

3.3 **Transmitter Characteristics**

3.3.1 Design Type: Pulsed-Plate Triode Amplifier

3.3.2 Frequency Range: Fixed, 5.4 to 5.9 GHz with replacement of modules

3.3.3 Transmitter Tuning: Factory tuning only

3.3.4 Frequency Stability: Locked to received frequency

3.3.5 Peak Power Output: 100 watts minimum, 200 watts typical

3.3.6 Power Spectrum: The RF bandwidth in MHz will not exceed 3.0/pulse width in microseconds measured at the quarter power point.

3.3.7 Spectral Purity: Spectrum nulls typically down 11 dB from peak

3.3.8 Spurious Radiation: None below transmitter second harmonic

3.3.9 Pulse Repetition Rate Range: 10 to 2600 pps

3.3.10 Duty Cycle: 0.0026

3.3.11 Pulse Width: 0.90 ±0.10 microsecond

3.3.12 Pulse Width Jitter: 0.01 microsecond maximum

3.3.13 Pulse Amplitude Variation: ±0.05 dB typical

3.3.14 Pulse Rise Time (10 to 90 percent): 0.05 microsecond maximum, 0.02 microsecond typical

3.3.15 Pulse Fall Time (90 to 10 percent): 0.05 microsecond maximum, 0.02 microsecond typical

3.4 **Delay Characteristics**

3.4.1 Absolute System Delay Variation: 0.020 microsecond typical, 0.030 microsecond maximum

3.4.2 Reply Delay Variations

3.4.2.1 Signal Strength Variation: 0.030 microsecond maximum, from 0 to -65 dBm

3.4.2.2 Interrogation Rate Variation: 0.005 microsecond maximum, from 10 to 2600 pps

3.4.2.3 Interrogation Frequency Variation: 0.005 microsecond, typical for frequency deviations of ±1 MHz

3.4.2.4 Pulse Code Spacing Variation: 0.005 microsecond, typical for code space T_c ±0.15 microsecond

3.4.2.5 Decision Pulse Rise Time Variation: 0.020 microsecond typical

3.4.2.6 Input Power Potential Variation: 0.005 microsecond typical

3.4.2.7 Temperature Variation: ±0.020 microsecond maximum, ±0.010 microsecond typical

3.4.2.8 Acceleration Variation: 0.010 microsecond maximum

3.4.3 Reply Delay Jitter: The standard deviation of pulse delay will not exceed 0.010 microsecond at -65 dBm

3.5 **Radio Frequency Load Matching Characteristics**

3.5.1 Input Impedance: 50 ohm nominal

3.5.2 Output Impedance: 50 ohm nominal

3.5.3 Open/Short Survival: The transponder will meet all requirements after application and removal of either a short or open circuit at the antenna terminal.

3.5.4 Voltage Standing Wave Ratio of Load: Will work into a VSWR of 1.5:1 typical

3.5.5 Duplexer Type: Four-port ferrite circulator

3.6 **Power Supply Characteristics**

3.6.1 Design Type: Series-pass regulator followed by a dc-dc converter

3.6.2 Input Voltage Range: 24 to 32 Vdc

3.6.3 Under Voltage/Over Voltage Protection: Not specified

3.6.4 Input Current, Quiescent: 0.5 A typical

3.6.5 Input Current, Interrogated at 1000 pulses per second: 0.7 A typical, at 32 Vdc

3.6.6 Transient Protection: Per MIL-STD-704B

3.6.7 Grounding and Isolation: Input power lines isolated from chassis ground by at least 1 megohm to dc

3.6.8 Standby Operation: Same as quiescent

3.7 **Design Characteristics**

3.7.1 Response to Valid Interrogations: 99 percent reply minimum at signal levels of 0 to -73 dBm

3.7.2 Random Triggering: Will not exceed 5 pps under any operating conditions

3.7.3 Transmitter-Receiver Frequency Separation: None

3.7.4 Off-Band Rejection Filter: 3-section preselector, tuned IF amplifier and 1-section bandpass filter

3.7.5 Mixer Diode Protection: Preselector protects diode from off-frequency RF; RF limiter protects mixer during transmit time

3.7.6 Power Delay Time: 20 second typical

3.7.7 Reverse Polarity Protection: Not specified

3.7.8 Over-Interrogation Protection: Provided to limit transmission rate to 2600 pps minimum, 2700 pps typical

3.7.9 Lock-Out Protection: Provides for no response during 50 microseconds recovery time of transponder

3.8 **Environmental Specifications**

3.8.1 Operating Temperature: +55°F (+13°C) to +160°F (+71°C)

3.8.2 Nonoperating Temperature: -65°F (-54°C) to +150°F (+66°C)

3.8.3 Pressure Altitude: Sea level to 50,000 feet during air transportation, unit is sealed for operation in space

3.8.4 Shock: Per specific reentry vehicle profile

3.8.5 Sine Vibration: Per specific reentry vehicle profile

3.8.6 Random Vibration: Per specific reentry vehicle profile

3.8.7 Acoustical Noise: Not specified

3.8.8 Random Noise: Not specified

3.8.9 Acceleration: Per specific reentry vehicle profile

3.8.10 Humidity: Per MIL-STD-810, Method 507, except the maximum temperature is 150°F

3.8.11 Salt Fog Atmosphere: Exposure to salt spray atmosphere encountered in sea coast areas

3.8.12 Rain: Not specified

3.8.13 Sand and Dust: Exposure to settling dust

3.8.14 Fungus: Per MIL-STD-810, Method 508.2

3.8.15 Missile Fuel Compatibility: Not specified

3.8.16 Electromagnetic Compatibility: Per MIL-STD-461B, Part 3 for class A2a equipment

3.9 **Physical/Mechanical Characteristics**

3.9.1 Form: Rectangular solid

3.9.2 Dimensions, Excluding Protrusions: 5.44 x 5.30 x 2.96 inches including mounting flange

3.9.3 Displacement Volume: Less than 90 cubic inches

3.9.4 Weight: 4.7 pounds typical

3.9.5 Pressurization: Sealed unit. Leakage rate less than 1×10^{-5} atmospheric cubic centimeters of helium per second.

3.9.6 Mounting Attitude: Any

3.9.7 Mounting Dimensions: 4 mounting holes 0.221 inch in diameter at the corners of a 4.75 inch square

3.9.8 Power and Test Connector: MS3449H-10C-6P

3.9.9 Radio Frequency Connector: Type SMA female

3.9.10 Type of External Controls: None

3.9.11 Pressurization Fitting Type: None

3.9.12 Grounding and Bonding: Grounding through power connector and chassis

3.9.13 Mounting Bracket: Not specified

3.9.14 Mounting Type: Not specified

3.10 **Auxiliary Functions**

3.10.1 External Output Signal Provisions: Raw Video and Signal Strength Telemetry

3.10.2 External Input Signal Provisions: None

3.10.3 External Adjustments: None

3.10.4 External Test Points: None

3.10.5 Internal Test Points: Provided to allow rapid isolation of malfunction to a particular module

3.11 **Coherent Velocity Specifications**

3.11.1 Pulse Coherence Doppler Error: Less than 0.12 Hz for 0.1 second smoothing time at prf's of 160 to 2600 pps

3.11.2 Dynamic Signal Strength Range: 0 to -70 dBm at prf's of 160 to 2600 pps

3.11.3 Spectral Skew: Less than 3 dB from ideal spectrum at ±350 kHz points

3.11.4 Carrier Line Width: Less than 2 Hz

3.11.5 Interline Noise: At least 20 dB (40 dB typical) below the carrier measured in a filter which has a 10-Hz bandwidth at prf's of 160 to 2600 pps

3.11.6 Frequency Locking Range: ±3 MHz minimum at prf's of 160 to 2600 pps

4.0 **QUALITY/RELIABILITY DATA**

4.1 **Reliability Characteristics**

4.1.1 Design Reliability: 0.99700 or greater when operated under the conditions of the specification for 2-hour preflight followed by an 11-minute flight period

4.1.2 Operational Stability: After 5-minute warmup, the transponder will operate within the performance limits of this specification for a minimum of 150 hours, continuously or intermittently without maintenance or adjustment

4.1.3 Service Life: Not specified

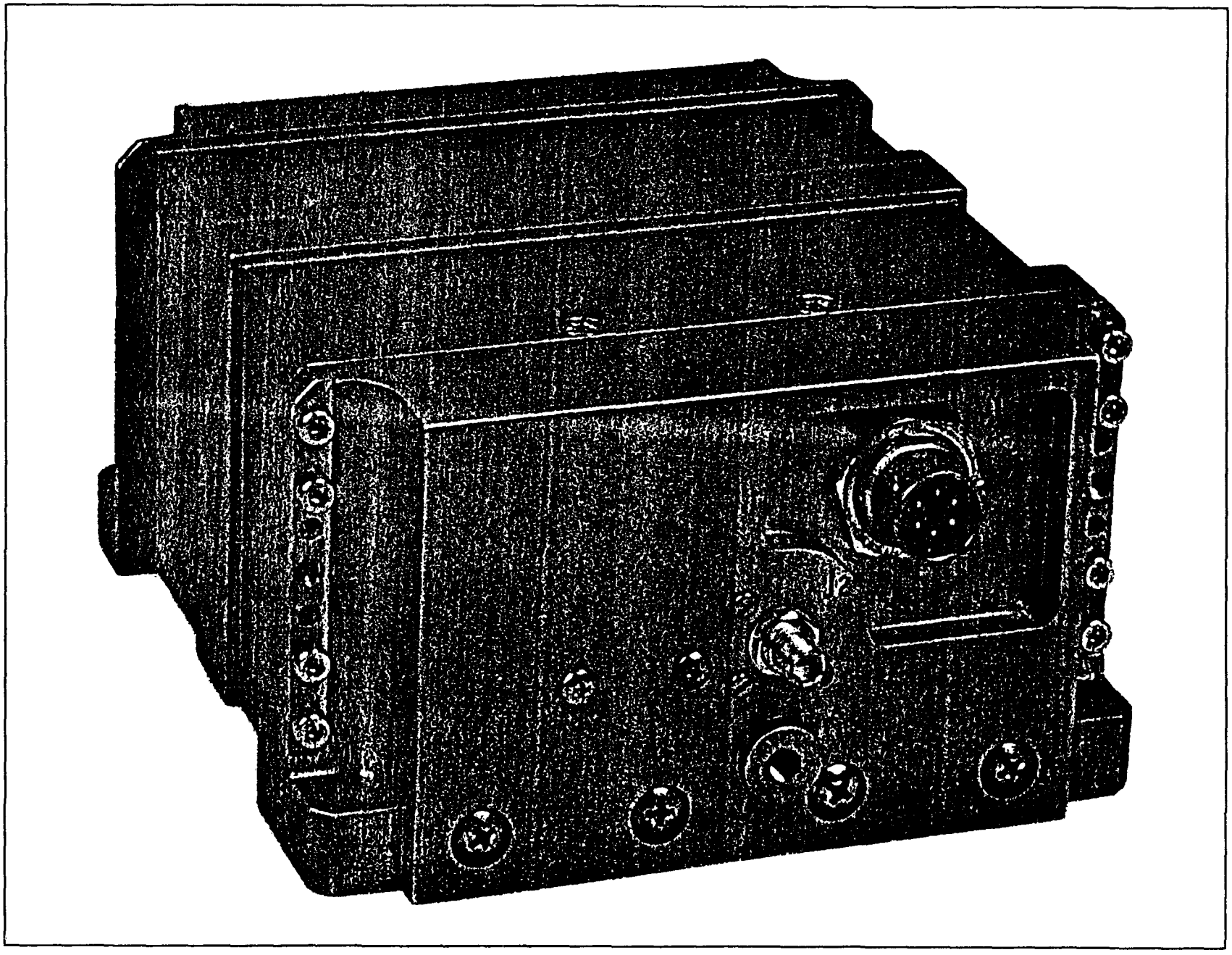

Figure 1-2. Model 355C-4 Transponder.

VEGA PRECISION LABORATORIES
G-BAND NONCOHERENT RADAR TRACKING TRANSPONDER

Manufacturer's Model Designation:	**369C**
Manufacturer's Part Number:	**405457-1**
Military Designation:	**Not assigned**
Federal Stock Number:	**Not assigned**

1.0 GENERAL DESCRIPTION

The model 369C is a G-Band Radar Transponder developed by Vega for command and control applications. It is designed for use as a receiver/transmitter with an external encoder/decoder. This highly accurate miniature transponder uses a triode cavity transmitter and superheterodyne receiver with automatic gain control (AGC). Its rugged design makes it well suited for applications in an aircraft environment.

2.0 DEVELOPMENT AND UTILIZATION

This unit was developed by Vega for G-band command and control applications with company funds.

3.0 TECHNICAL SPECIFICATIONS

3.1 General Characteristics

3.1.1 Frequency Range: 5.4 to 5.9 GHz

3.1.2 Trigger Sensitivity: -65 dBm minimum

3.1.3 Peak Power Output: 50 watts minimum

3.1.4 Standard Reply Delay: 2.5 ±0.1 microseconds

3.1.5 Interrogation Pulse Coding: Not applicable, use with external encoder/decoder

3.1.6 Pulse Repetition Frequency Response Range: 100 to 2600 pps

3.1.7 Recovery Time: 50 microseconds maximum

3.1.8 Nominal Operating Voltage: 22 to 32 Vdc

3.1.9 Operating Stabilization Time: 3 minutes maximum

3.2 **Receiver/Decoder Characteristics**

3.2.1 Design Type: Superheterodyne

3.2.2 Frequency Range: 5.4 to 5.9 GHz

3.2.3 Receiver Tuning: Single local oscillator tuning control and 3 preselector tuning controls accessible from exterior of unit

3.2.4 Frequency Stability: ±5 MHz after 3 minute warmup

3.2.5 3 dB Bandwidth: 13 ±5 MHz

3.2.6 40 dB Bandwidth: 90 MHz typical

3.2.7 Off-Frequency and Image Rejection: 60 dB minimum

3.2.8 Dynamic Signal Range: +10 to -65 dBm

3.2.9 Maximum Input Signal: +10 dBm

3.2.10 Pulse Width Acceptance: 0.25 to 1.0 microsecond

3.2.11 Pulse Rise Time Acceptance: 0.1 microsecond or less

3.2.12 Pulse Code Spacing: Not applicable, use with external encoder/decoder

3.2.13 Decoder Accept Limits: Not applicable

3.2.14 Decoder Reject Limits: Not applicable

3.2.15 Delay Decision Pulse Trigger Point (Percent of rise time): Not specified

3.3 **Transmitter Characteristics**

3.3.1 Design Type: Triode Cavity

3.3.2 Frequency Range: 5.4 to 5.9 GHz

3.3.3 Transmitter Tuning: Single control accessible from exterior of unit

3.3.4 Frequency Stability: ±5 MHz for all operating conditions

3.3.5 Peak Power Output: 50 watts minimum

3.3.6 Power Spectrum: The RF bandwidth in MHz will not exceed 3.0/pulse width in microseconds measured at the quarter power point.

3.3.7 Spectral Purity: Not specified

3.3.8 Spurious Radiation: Not specified

3.3.9 Pulse Repetition Rate Range: 100 to 2600 pps

3.3.10 Duty Cycle: 0.0015 maximum

3.3.11 Pulse Width: 0.5 microsecond nominal, adjustable 0.47 to 0.53 microsecond

3.3.12 Pulse Width Jitter: 0.01 microsecond maximum

3.3.13 Pulse Amplitude Variation: Not specified

3.3.14 Pulse Rise Time (10 to 90 percent): 0.1 microsecond maximum

3.3.15 Pulse Fall Time (90 to 10 percent): 0.2 microsecond maximum

3.4 **Delay Characteristics**

3.4.1 Absolute System Delay Variation: Not specified

3.4.2 Reply Delay Variations

3.4.2.1 Signal Strength Variation: Not specified

3.4.2.2 Interrogation Rate Variation: Not specified

3.4.2.3 Interrogation Frequency Variation: Not specified

3.4.2.4 Pulse Code Spacing Variation: Not specified

3.4.2.5 Decision Pulse Rise Time Variation: Not specified

3.4.2.6 Input Power Potential Variation: Not specified

3.4.2.7 Acceleration Variation: Not specified

3.4.3 Reply Delay Jitter: Will not exceed 0.02 microsecond peak to peak for input signal levels of 0 to -55 dBm. Will not exceed 0.05 microsecond for input signal levels of -55 to -65 dBm.

3.5 **Radio Frequency Load Matching Characteristics**

3.5.1 Input Impedance: 50 ohm nominal

3.5.2 Output Impedance: 50 ohm nominal

3.5.3 Open/Short Survival: Transmitter will meet all requirements after application and removal of either a short or an open circuit at the antenna terminal.

3.5.4 Voltage Standing Wave Ratio of Load: Will work into a VSWR of 2:1 typically

3.5.5 Duplexer Type: Four-port ferrite circulator

3.6 **Power Supply Characteristics**

3.6.1 Design Type: Series pass regulator with dc-dc converter

3.6.2 Input Voltage Range: 22 to 32 Vdc

3.6.3 Under Voltage/Over Voltage Protection: Not specified

3.6.4 Input Current, Quiescent: 300 mA maximum

3.6.5 Input Current, Interrogated at 1000 pulses per second: 400 mA maximum

3.6.6 Transient Protection: Per MIL-STD-704A, Category B

3.6.7 Grounding and Isolation: Input power lines isolated from chassis ground

3.6.8 Standby Operation: Same as quiescent

3.7 **Design Characteristics**

3.7.1 Response to Valid Interrogations: Will reply to 99 percent of interrogation signals at all input signal levels of 0 to -65 dBm.

3.7.2 Random Triggering: Will not exceed 10 pps under any operating conditions

3.7.3 Transmitter-Receiver Frequency Separation: 50 MHz minimum

3.7.4 Off-Band Rejection Filter: Three-section preselector and tuned IF amplifier

3.7.5 Mixer Diode Protection: Preselector protects diode from off-frequency RF

3.7.6 Power Delay Time: 30 seconds

3.7.7 Reverse Polarity Protection: Provided to prevent permanent damage upon application of reverse polarity dc input voltage

3.7.8 Over-Interrogation Protection: Provided to limit transmission duty cycle to 0.002

3.7.9 Lock-Out Protection: Provides for no response during 50 microseconds recovery time of transponder

3.8 **Environmental Specifications**

3.8.1 Operating Temperature: -54°C to +85°C (-65°F to +185°F)

3.8.2 Nonoperating Temperature: -62°C to +100°C (-80°F to +212°F)

3.8.3 Pressure Altitude: 760 mm through 0.04 mm of mercury (230,000 feet)

3.8.4 Shock: MIL-STD-810C, Method 516.2, Procedure IV, pulse shape per Figure 516.2-1 for flight vehicle equipment (6 millisecond pulse duration) transponder operating

3.8.5 Sine Vibration: MIL-STD-810C, Method 514.2, Equipment Category e, Procedure V, Table 514.2-V, Part 1, Figure 514.2-5, Curve S

3.8.6 Random Vibration: MIL-STD-810C, Method 514.2, Equipment Category e, Procedure V, Table 514.2-V, Part 2, Figure 514.2-5, Curve AJ

3.8.7 Acoustical Noise: MIL-STD-810C, Method 515.2, Procedure I, Category A

3.8.8 Random Noise: Not specified

3.8.9 Acceleration: MIL-STD-810C, Method 513.2, Procedure II, Table 513.2-II, ground launched missiles with unknown acceleration, transponder operating

3.8.10 Humidity: Meets MIL-STD-810C, Method 507.1, Procedure I (change step 5 to read 2 cycles)

3.8.11 Salt Fog Atmosphere: Meets MIL-STD-810C, Method 509.1, Procedure I

3.8.12 Rain: Meets MIL-STD-810C, Method 506.1, Procedure II

3.8.13 Sand and Dust: Meets MIL-STD-810C, Method 510.1, Procedure I

3.8.14 Fungus: Meets MIL-STD-810C, Method 508.1, Procedure I

3.8.15 Missile Fuel Compatibility: MIL-STD-810C, Method 511.1, Procedure I with the exception that the transponder cover will not be loosened before or during the tests

3.8.16 Electromagnetic Compatibility: MIL-STD-461A, Notices 1 and 3, Methods: CE03, CE06, CS02, CS03, CS04, RE02, RS03, and RS02

3.9 **Physical/Mechanical Characteristics**

3.9.1 Form: Rectangular solid

3.9.2 Dimensions, Excluding Protrusions: 4.25 x 3.50 x 2.00 inches

3.9.3 Displacement Volume: 24.5 cubic inches

3.9.4 Weight: 26 ounces

3.9.5 Pressurization: Maintains interior pressure 15 psi above exterior pressure for 8 hours

3.9.6 Mounting Attitude: Any

3.9.7 Mounting Dimensions: 4 mounting holes 0.156 inches diameter, spaced 2.1 inches apart on opposite sides

3.9.8 Power and Test Connector: MS27476YO8D35P

3.9.9 Radio Frequency Connector: SMA female

3.9.10 Type of External Controls: None

3.9.11 Pressurization Fitting Type: Adapter Vega Part Number 203629-1

3.9.12 Grounding and Bonding: Not necessary

3.9.13 Mounting Bracket: None

3.9.14 Mounting Type: Not specified

3.10 **Auxiliary Functions**

3.10.1 External Output Signal Provisions: Telemetry Output (Receiver Video, +3 volt pulses into 50 ohm), Temperature Sensor Output (200 ohm Platinum Resistor), AGC Monitor Voltage (Receiver Signal Strength, 0 to +5 volts)

3.10.2 External Input Signal Provisions: Telemetry Input (Transmitter Trigger Input, +3 volt pulses terminated in 50 ohm), AGC Gate Input (+3 volt pulses gate receiver video to AGC circuit)

3.10.3 External Adjustments: Transmitter tuning, local oscillator and preselector

3.10.4 External Test Points: Not specified

3.10.5 Internal Test Points: Provided to allow rapid isolation of a malfunction to a particular module

3.11 **Coherent Velocity Specifications**

3.11.1 Pulse Coherence Doppler Error: Not applicable

3.11.2 Dynamic Signal Strength Range: Not applicable

3.11.3 Spectral Skew: Not applicable

3.11.4 Carrier Line Width: Not applicable

3.11.5 Interline Noise: Not applicable

3.11.6 Frequency Locking Range: Not applicable

4.0 **QUALITY/RELIABILITY DATA**

4.1 **Reliability Characteristics**

4.1.1 Design Reliability: Not specified

4.1.2 Operational Stability: Not specified

4.1.3 Service Life: Unlimited with proper maintenance and replacement of parts

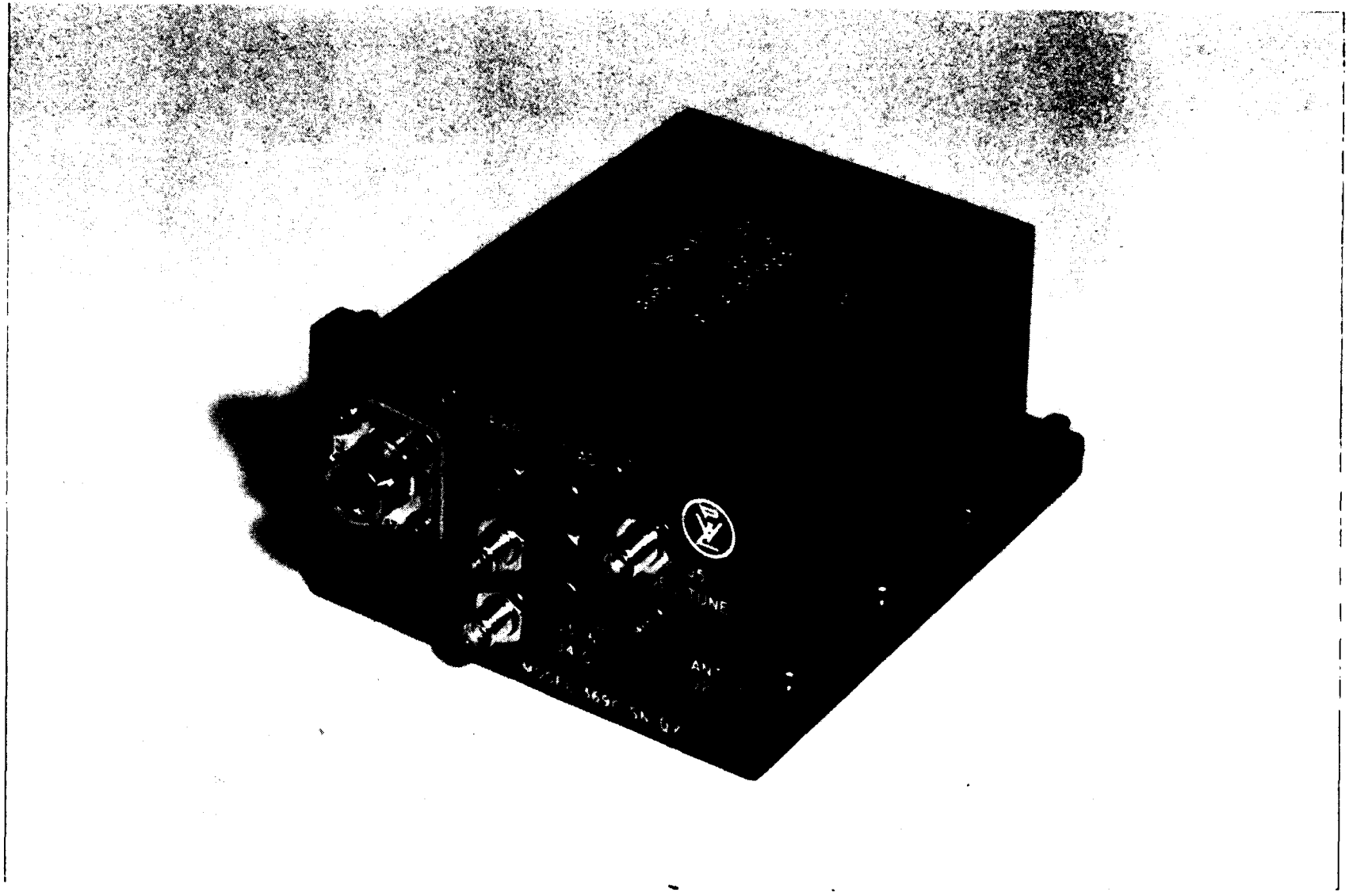

Figure 1-3. Model 369C G-Band Radar Transponder.

VEGA PRECISION LABORATORIES
G-BAND NONCOHERENT RADAR TRACKING TRANSPONDER

Manufacturer's Model Designation:	**RT374C-1**
Manufacturer's Part Number:	**409793-1**
Military Designation:	**Not specified**
Federal Stock Number:	**Not specified**

1.0 GENERAL DESCRIPTION

The model RT374C-1 is an extremely compact G-band noncoherent radar tracking transponder designed for use with G-band tracking radars. The unit is designed for satellite and missile applications where S-level parts are required.

2.0 DEVELOPMENT AND UTILIZATION

The model RT374C-1 was designed and developed by Vega Precision Laboratories under contract with General Dynamics for the Titan/Centaur program.

3.0 TECHNICAL SPECIFICATIONS

3.1 General Characteristics

3.1.1 Frequency Range: 5.4 to 5.9 GHz

3.1.2 Trigger Sensitivity: -70 dBm minimum

3.1.3 Peak Power Output: 400 watts minimum, 700 watts maximum

3.1.4 Standard Reply Delay: 1.0 to 5.0 microseconds selectable

3.1.5 Interrogation Pulse Coding: Single or double pulse selectable

3.1.6 Pulse Repetition Frequency Response Range: 10 to 2600 pps

3.1.7 Recovery Time: 50 microseconds maximum

3.1.8 Nominal Operating Voltage: 24.6 to 32 Vdc

3.1.9 Operating Stabilization Time: 5 minutes

3.2 **Receiver/Decoder Characteristics**

3.2.1 Design Type: Superheterodyne

3.2.2 Frequency Range: 5.4 to 5.9 GHz

3.2.3 Receiver Tuning: Single local oscillator tuning control and three preselector tuning controls accessible from exterior of unit

3.2.4 Frequency Stability: ±2 MHz

3.2.5 3 dB Bandwidth: 11 ±3 MHz

3.2.6 40 dB Bandwidth: 90 MHz typical

3.2.7 Off-Frequency and Image Rejection: Image rejection 60 dB minimum

3.2.8 Dynamic Signal Range: +10 to -70 dBm

3.2.9 Maximum Input Signal: +20 dBm

3.2.10 Pulse Width Acceptance: 1.0 +0.2 microsecond, single pulse. 0.25 to 1.0 microsecond, double pulse

3.2.11 Pulse Rise Time Acceptance: 0.1 microsecond or less

3.2.12 Pulse Code Spacing: 3.0 to 12.0 microseconds selectable in 1 microsecond increments

3.2.13 Decoder Accept Limits: ±0.15 microsecond

3.2.14 Decoder Reject Limits: ±0.30 microsecond

3.2.15 Delay Decision Pulse Trigger Point (Percent of rise time): Not specified

3.3 **Transmitter Characteristics**

3.3.1 Design Type: Magnetron

3.3.2 Frequency Range: 5.4 to 5.9 GHz

3.3.3 Transmitter Tuning: Single control accessible from exterior of unit

3.3.4 Frequency Stability: ±3.0 MHz under all conditions

3.3.5 Peak Power Output: 400 watts minimum, 700 watts maximum

3.3.6 Power Spectrum: The RF bandwidth in MHz will not exceed 3.0/pulse width in microseconds measured at the quarter power point.

3.3.7 Spectral Purity: Not specified

3.3.8 Spurious Radiation: Spurious radiation over the band of 0.15 MHz to 10,000 MHz shall be at least 60 dB below transmitter output for transmitter harmonics and at least 80 dB below transmitter output for other outputs.

3.3.9 Pulse Repetition Rate Range: 10 to 2600 pulses per second

3.3.10 Duty Cycle: 0.002 maximum

3.3.11 Pulse Width: 0.5 ±0.1 microsecond

3.3.12 Pulse Width Jitter: Less than 0.01 microsecond peak to peak at one-half power points

3.3.13 Pulse Amplitude Variation: Not specified

3.3.14 Pulse Rise Time (10 to 90 percent): 0.1 microsecond maximum

3.3.15 Pulse Fall Time (90 to 10 percent): 0.2 microsecond maximum

3.4 **Delay Characteristics**

3.4.1 Absolute System Delay Variation: Not specified

3.4.2 Reply Delay Variations

3.4.2.1 Signal Strength Variation: Delay variation will not exceed 0.03 microsecond for signal levels from +10 to -65 dBm. Delay variation will not exceed 0.15 microsecond for signal levels of +10 to -70 dBm.

3.4.2.2 Interrogation Rate Variation: Not specified

3.4.2.3 Interrogation Frequency Variation: Not specified

3.4.2.4 Pulse Code Spacing Variation: Not specified

3.4.2.5 Decision Pulse Rise Time Variation: Not specified

3.4.2.6 Input Power Potential Variation: Not specified

3.4.2.7 Acceleration Variation: Not specified

3.4.3 Reply Delay Jitter: Less than 0.02 microsecond peak to peak, for signal levels of +10 to -55 dBm, less than 0.05 microsecond from -55 to -65 dBm, or 0.1 microsecond from -65 to -70 dBm.

3.5 **Radio Frequency Load Matching Characteristics**

3.5.1 Input Impedance: 50 ohm nominal

3.5.2 Output Impedance: 50 ohm nominal

3.5.3 Open/Short Survival: Transmitter shall meet all requirements after application and removal of either a short or open circuit at the antenna terminal.

3.5.4 Voltage Standing Wave Ratio of Load: Will operate in conjunction with an antenna system having a VSWR of 2.5:1 at all phase angles.

3.5.5 Duplexer Type: Four-port ferrite circulator

3.6 **Power Supply Characteristics**

3.6.1 Design Type: Primary regulated dc-dc converter

3.6.2 Input Voltage Range: 24.6 to 32 Vdc

3.6.3 Under Voltage/Over Voltage Protection: Not specified

3.6.4 Input Current, Quiescent: 0.65 ampere maximum

3.6.5 Input Current, Interrogated at 2600 pulses per second: 1.0 ampere maximum

3.6.6 Transient Protection: ±100 volts at 100 microseconds maximum duration

3.6.7 Grounding and Isolation: Input power lines isolated from chassis ground

3.6.8 Standby Operation: Same a's quiescent

3.7 **Design Characteristics**

3.7.1 Response to Valid Interrogations: Shall trigger at least 99 percent replies to signals at level between +10 to -70 dBm applied to the transponder antenna connector

3.7.2 Random Triggering: Will not exceed 10 pulses per second under any operating conditions

3.7.3 Transmitter-Receiver Frequency Separation: 50 MHz, minimum

3.7.4 Off-Band Rejection Filter: Three-section preselector and tuned IF amplifier

3.7.5 Mixer Diode Protection: Preselector protects diode from off-frequency RF

3.7.6 Power Delay Time: 120 seconds

3.7.7 Reverse Polarity Protection: Provided on 28 Vdc line

3.7.8 Over-Interrogation Protection: Provided to limit transmitter duty cycle to 0.002

3.7.9 Lock-Out Protection: Provides for no response during 50 microseconds recovery time of transponder

3.8 **Environmental Specifications**

3.8.1 Operating Temperature: -54°C to +71°C (-65°F to +160°F)

3.8.2 Nonoperating Temperature: -54°C to +71°C (-65°F to +160°F)

3.8.3 Pressure Altitude: From 760 mmHg to 1 x 10^{-10} mmHg

3.8.4 Shock: Pyrotechnic Separation Shock

3.8.5 Sine Vibration: Not specified

3.8.6 Random Vibration:

Duration/Axis(Sec)	Freq Range (Hz)	Amplitude/Slope
60	20 to 50	+6 db/octave
	50 to 140	0.48g^2 /Hz
	140 to 180	*
	180 to 420	0.32g^2 /Hz
	420 to 2000	-9 db/octave
	Overall	14.4g rms

3.8.7 Acoustical Noise: Not specified

3.8.8 Random Noise: Not specified

3.8.9 Acceleration: 9g along three orthogonal axes for at least 30 seconds in both directions (180 seconds total)

3.8.10 Humidity: Up to 100 percent

3.8.11 Salt Fog Atmosphere: Salt concentration of 2.35 percent by weight with a hydrogen ion concentration having a pH of 6.8 to 7.2 at 95 ±3°F for a duration of 50 hours

3.8.12 Rain: Water at the rate of 3 to 5 inches per hour in the form of droplets for a duration of 2 hours

3.8.13 Sand and Dust: Not specified

3.8.14 Fungus: Not specified

3.8.15 Missile Fuel Compatibility: Not specified

3.8.16 Electromagnetic Compatibility: MIL-STD-1541, Modified, Methods CE01, CE03, CE06, CS01, CS02, CS06, RE02, RS02, and RS03

3.9 **Physical/Mechanical Characteristics**

3.9.1 Form: Rectangular solid

3.9.2 Dimensions, Excluding Protrusions: 4.40 x 2.40 x 3.85 inches

3.9.3 Displacement Volume: 45 cubic inches

3.9.4 Weight: 64 ounces maximum

3.9.5 Pressurization: Not specified

3.9.6 Mounting Attitude: Any

3.9.7 Mounting Dimensions: 4 holes 0.169 diameter, at corners of a 3.420 x 2.680 inch rectangle

3.9.8 Power and Test Connector: MS3114H10C-6P (mating connector NB6GE10-6SNS3 MSFC 40M39569)

3.9.9 Radio Frequency Connector: TNC female

3.9.10 Type of External Controls: Local oscillator tuning, transmitter tuning, and preselector tuning

3.9.11 Pressurization Fitting Type: Not specified

3.9.12 Grounding and Bonding: Not necessary

3.9.13 Mounting Bracket: Not specified

3.9.14 Mounting Type: Not specified

3.10 **Auxiliary Functions**

3.10.1 External Output Signal Provisions: Not specified

3.10.2 External Input Signal Provisions: Not specified

3.10.3 External Adjustments: Transmitter tuning, local oscillator tuning, and preselector tuning

3.10.4 External Test Points: Not specified

3.10.5 Internal Test Points: Provided to allow rapid isolation of malfunction to a particular module

3.11 **Coherent Velocity Specifications**

3.11.1 Pulse Coherence Doppler Error: Not applicable

3.11.2 Dynamic Signal Strength Range: Not applicable

3.11.3 Spectral Skew: Not applicable

3.11.4 Carrier Line Width: Not applicable

3.11.5 Interline Noise: Not applicable

3.11.6 Frequency Locking Range: Not applicable

4.0 **QUALITY/RELIABILITY DATA**

4.1 **Reliability Characteristics**

4.1.1 Design Reliability: Not specified

4.1.2 Operational Stability: Not specified

4.1.3 Service Life: The useful life is 10 years with normal servicing, maintenance, and replacement parts. The operating life is 10,000 hours minimum, throughout the useful life of the transponder.

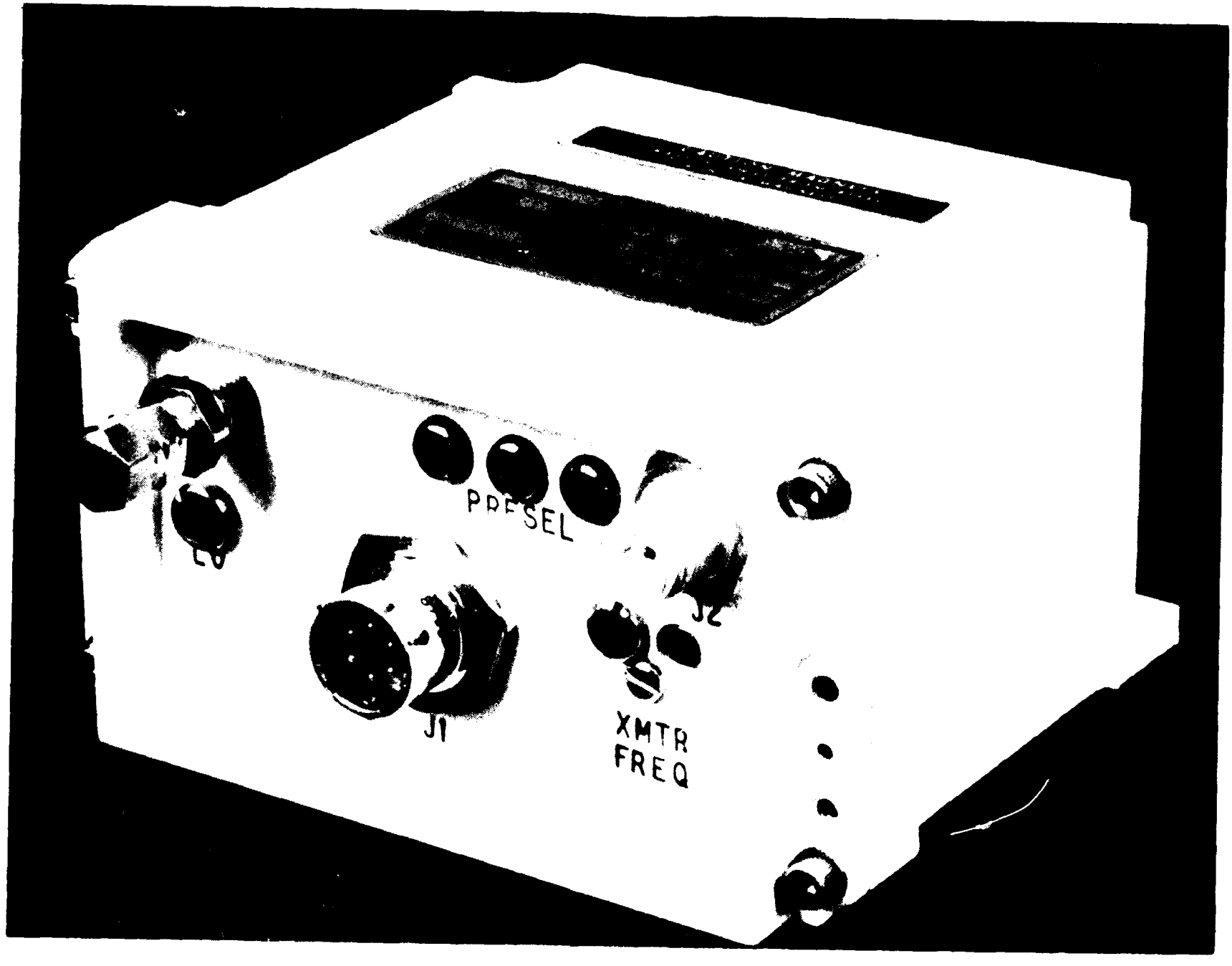

Figure 1-4. Model E1374C-1 Transponder.

VEGA PRECISION LABORATORIES
G-BAND NONCOHERENT RADAR TRACKING TRANSPONDER

Manufacturer's Model Designation:	**380C**
Manufacturer's Part Number:	**408791-1**
Military Designation:	**AN/DPN-90(V)1**
Federal Stock Number:	**1420-01-284-3043**

1.0 GENERAL DESCRIPTION

The model 380C transponder is a second generation unit designed to replace the 302C-2. It is a medium power unit used in conjunction with tracking radars and offers the test range users a low-cost approach to tracking airborne vehicles.

This unit features modular construction for ease of repair and was designed for very low-cost from its inception. To better meet mission requirements, this G-band transponder is interchangeable in weight, outline, footprint, and electrical interface with the I-band 380X.

2.0 DEVELOPMENT AND UTILIZATION

This unit was developed by Vega under contract with the U.S. Navy as a low-cost replacement for the Vega model 302C-2.

3.0 TECHNICAL SPECIFICATIONS

3.1 General Characteristics

3.1.1 Frequency Range: 5.4 to 5.9 GHz

3.1.2 Trigger Sensitivity: -70 dBm minimum

3.1.3 Peak Power Output: 300 watts minimum

3.1.4 Standard Reply Delay: 1.5 to 6.0 microseconds adjustable

3.1.5 Interrogation Pulse Coding: Single or double pulse selectable

3.1.6 Pulse Repetition Frequency Response Range: 0 to 3000 pps

3.1.7 Recovery Time: 50 microseconds maximum

3.1.8 Nominal Operating Voltage: 21 to 31 Vdc

3.1.9 Operating Stabilization Time: 180 seconds

3.2 **Receiver/Decoder Characteristics**

3.2.1 Design Type: Superheterodyne

3.2.2 Frequency Range: 5.4 to 5.9 GHz

3.2.3 Receiver Tuning: Single local oscillator tuning control and three preselector tuning controls accessible from exterior of unit

3.2.4 Frequency Stability: ±2 MHz

3.2.5 3 dB Bandwidth: 11 ±3 MHz

3.2.6 40 dB Bandwidth: 90 MHz typical

3.2.7 Off-Frequency and Image Rejection: Image rejection 60 dB minimum

3.2.8 Dynamic Signal Range: 0 to -70 dBm

3.2.9 Maximum Input Signal: +2 dBm

3.2.10 Pulse Width Acceptance: 1.0 ±0.2 microseconds single pulse, 0.25 to 0.5 microsecond double pulse

3.2.11 Pulse Rise Time Acceptance: 0.1 microsecond or less

3.2.12 Pulse Code Spacing: 3.0 to 12.0 microseconds adjustable

3.2.13 Decoder Accept Limits: ±0.15 microsecond

3.2.14 Decoder Reject Limits: ±0.30 microsecond

3.2.15 Delay Decision Pulse Trigger Point (Percent of rise time): Not specified

3.3 **Transmitter Characteristics**

3.3.1 Design Type: Magnetron

3.3.2 Frequency Range: 5.4 to 5.9 GHz

3.3.3 Transmitter Tuning: Single control accessible from exterior of unit

3.3.4 Frequency Stability: ±2.5 MHz under all conditions

3.3.5 Peak Power Output: 300 watts minimum

3.3.6 Power Spectrum: The RF bandwidth in MHz will not exceed 3.0/pulse width in microseconds measured at the quarter power point.

3.3.7 Spectral Purity: Not specified

3.3.8 Spurious Radiation: Not specified

3.3.9 Pulse Repetition Rate Range: 0 to 3000 pulses per second

3.3.10 Duty Cycle: 0.002 maximum

3.3.11 Pulse Width: 0.5 ±0.1 microsecond

3.3.12 Pulse Width Jitter: Not specified

3.3.13 Pulse Amplitude Variation: Not specified

3.3.14 Pulse Rise Time (10 to 90 percent): 0.1 microsecond maximum

3.3.15 Pulse Fall Time (90 to 10 percent): 0.2 microsecond maximum

3.4 **Delay Characteristics**

3.4.1 Absolute System Delay Variation: Not specified

3.4.2 Reply Delay Variations

3.4.2.1 Signal Strength Variation: ±0.05 microsecond from 0 to -65 dBm

3.4.2.2 Interrogation Rate Variation: Not specified

3.4.2.3 Interrogation Frequency Variation: Not specified

3.4.2.4 Pulse Code Spacing Variation: Not specified

3.4.2.5 Decision Pulse Rise Time Variation: Not specified

3.4.2.6 Input Power Potential Variation: Not specified

3.4.2.7 Acceleration Variation: Not specified

3.4.3 Reply Delay Jitter: ±0.05 microsecond at an input signal level of -55 to -65 dBm. ±0.02 microsecond at input signal level of 0 to -55 dBm.

3.5 **Radio Frequency Load Matching Characteristics**

3.5.1 Input Impedance: 50 ohm nominal

3.5.2 Output Impedance: 50 ohm nominal

3.5.3 Open/Short Survival: Transmitter shall meet all requirements after application and removal of either a short or open circuit at the antenna terminal.

3.5.4 Voltage Standing Wave Ratio of Load: Will operate in conjunction with an antenna system having a VSWR of 2:1 at all phase angles.

3.5.5 Duplexer Type: Four-port ferrite circulator

3.6 **Power Supply Characteristics**

3.6.1 Design Type: Primary regulated dc-dc converter

3.6.2 Input Voltage Range: 21 to 31 Vdc

3.6.3 Under Voltage/Over Voltage Protection: Not specified

3.6.4 Input Current, Quiescent: 1.0 ampere maximum

3.6.5 Input Current, Interrogated at 3000 pulses per second: 1.5 ampere maximum

3.6.6 Transient Protection: MIL-STD-704 (Tailored)

3.6.7 Grounding and Isolation: Input power lines isolated from chassis ground

3.6.8 Standby Operation: Same as quiescent

3.7 **Design Characteristics**

3.7.1 Response to Valid Interrogations: Shall trigger at least 99 percent replies to signals at level between 0 to -70 dBm applied to the transponder antenna connector

3.7.2 Random Triggering: Will not exceed 10 pulses per minute averaged over a 10-minute interval

3.7.3 Transmitter-Receiver Frequency Separation: 50 MHz minimum

3.7.4 Off-Band Rejection Filter: Three-section preselector and tuned IF amplifier

3.7.5 Mixer Diode Protection: Preselector protects diode from off frequency RF

3.7.6 Power Delay Time: 180 seconds

3.7.7 Reverse Polarity Protection: Provided on 28 Vdc line

3.7.8 Over-Interrogation Protection: Provided to limit transmitter duty cycle to 0.002

3.7.9 Lock-Out Protection: Provides for no response during 50 microseconds recovery time of transponder

3.8 **Environmental Specifications**

3.8.1 Operating Temperature: -54°C to +71°C (-65°F to +160°F)

3.8.2 Nonoperating Temperature: -62°C to +85°C (-80°F to +185°F)

3.8.3 Pressure Altitude: 100,000 feet

3.8.4 Shock: 18 half sine impact shocks of 100g consisting of 3 shocks in opposite directions along each of 3 mutually perpendicular axes, each shock impulse having a time duration of 11 milliseconds

3.8.5 Sine Vibration: MIL-E-5400T, Figure 2, Curve IVa, 3 axes. Logarithmic sweep 5-2000-5 Hz in 20 minutes, log level. Total Vibration 1 hour per axis

3.8.6 Random Vibration: Not specified

3.8.7 Acoustical Noise: Not specified

3.8.8 Random Noise: Not specified

3.8.9 Acceleration: Not specified

3.8.10 Humidity: Not specified (Will withstand submergence in 3 feet of water for 1 hour without water intrusion)

3.8.11 Salt Fog Atmosphere: Not specified (The transponders exterior surfaces show no signs of corrosion after emersion in sea water.)

3.8.12 Rain: Not specified (Will withstand submersion in 3 feet of water for 1 hour without water intrusion)

3.8.13 Sand and Dust: Not specified

3.8.14 Fungus: Not specified

3.8.15 Missile Fuel Compatibility: Not specified

3.8.16 Electromagnetic Compatibility: MIL-STD-461B, Class A1, Methods CE03, RE03, CS01, CS02, CS06, RE02, and RS03

3.9 **Physical/Mechanical Characteristics**

3.9.1 Form: Rectangular solid

3.9.2 Dimensions, Excluding Protrusions: 4.27 x 4.68 x 2.26 inches

3.9.3 Displacement Volume: 43 cubic inches

3.9.4 Weight: 45 ounces maximum

3.9.5 Pressurization: 16.0 ±0.5 pounds per square inch maximum

3.9.6 Mounting Attitude: Any

3.9.7 Mounting Dimensions: 6 holes 0.173 diameter, 1 hole on centerline front and rear spaced 4.69 inches apart. 1 hole 1.84 inches either side of centerline front and rear.

3.9.8 Power and Test Connector: MS3114H8C-4P (mates with MS3116E8-4S)

3.9.9 Radio Frequency Connector: TNC female

3.9.10 Type of External Controls: None

3.9.11 Pressurization Fitting Type: Schraeder type with protective cap

3.9.12 Grounding and Bonding: Not necessary

3.9.13 Mounting Bracket: Not specified

3.9.14 Mounting Type: Not specified

3.10 **Auxiliary Functions**

3.10.1 External Output Signal Provisions: Not specified

3.10.2 External Input Signal Provisions: Not specified

3.10.3 External Adjustments: Transmitter tuning, receiver tuning, sensitivity, decoder, delay, and transmitter pulse width

3.10.4 External Test Points: Not specified

3.10.5 Internal Test Points: Provided to allow rapid isolation of malfunction to a particular module

3.11 **Coherent Velocity Specifications**

3.11.1 Pulse Coherence Doppler Error: Not applicable

3.11.2 Dynamic Signal Strength Range: Not applicable

3.11.3 Spectral Skew: Not applicable

3.11.4 Carrier Line Width: Not applicable

3.11.5 Interline Noise: Not applicable

3.11.6 Frequency Locking Range: Not applicable

4.0 **QUALITY/RELIABILITY DATA**

4.1 **Reliability Characteristics**

4.1.1 Design ReliabilitY: Lower test mean time between failure (MTBF) of 50 hours and an upper test MTBF of 100 hours when tested in accordance with MIL-STD-781

4.1.2 Operational Stability: 25 hours without adjustment

4.1.3 Service Life: 1000 hours minimum, with minimal servicing and replacement of parts

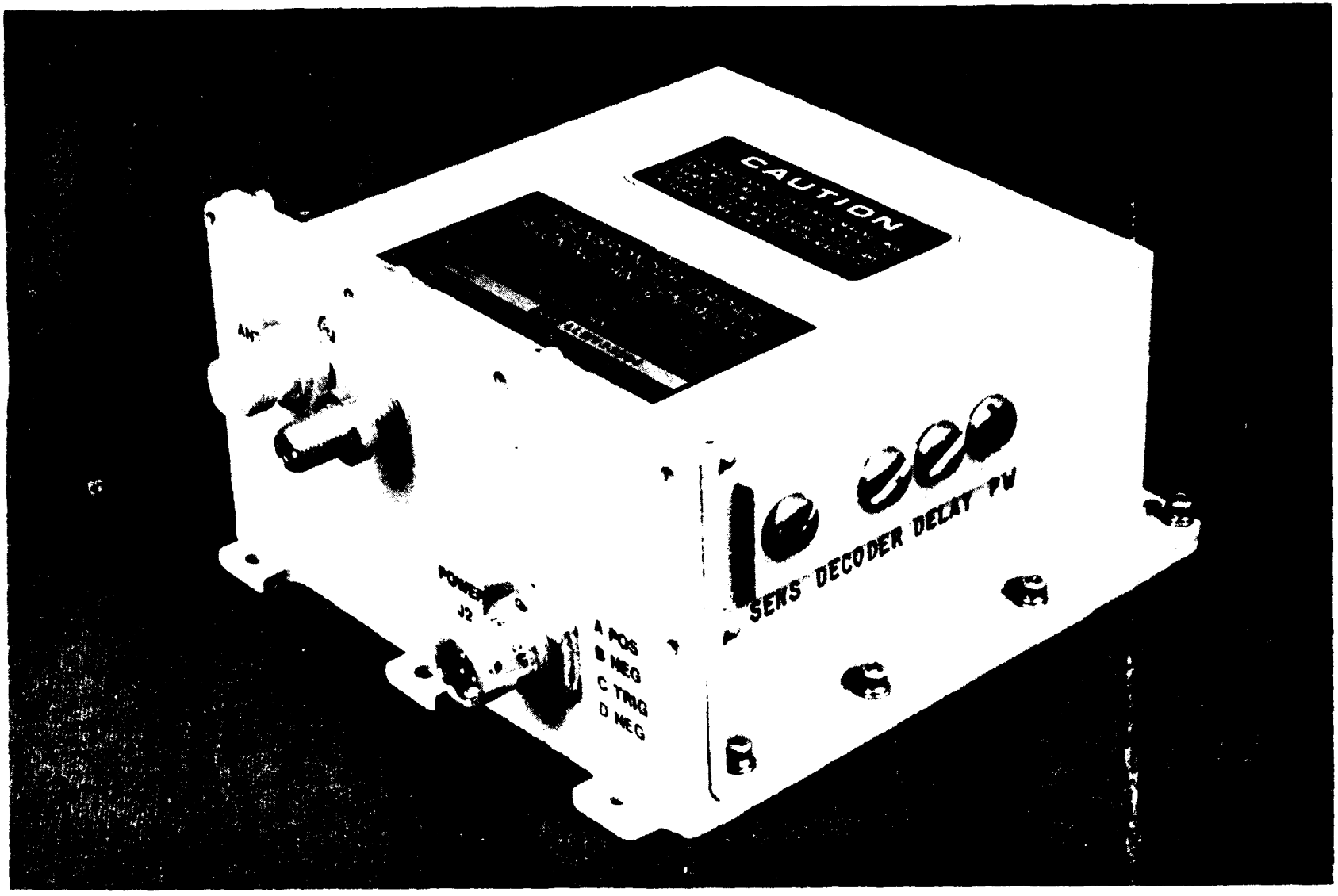

Figure 1-5 Model 380C G-Band Radar Transponder.

VEGA PRECISION LABORATORIES
G-BAND NONCOHERENT RADAR TRACKING TRANSPONDER

Manufacturer's Model Designation:	**RT385**
Manufacturer's Part Number:	**409773-1**
Military Designation:	**Not assigned**
Federal Stock Number:	**Not assigned**

1.0 GENERAL DESCRIPTION

The model RT385 was developed by Vega as a G-band radar enhancement device for reentry vehicle applications. It uses Hi-Rel JANTXV parts and can withstand the high-dynamic environment. The excellent delay and jitter variation characteristics provide for accurate vehicle tracking.

2.0 DEVELOPMENT AND UTILIZATION

This unit was developed by Vega for use in reentry vehicles as an enhancement device for G-band tracking radars.

3.0 TECHNICAL SPECIFICATIONS

3.1 General Characteristics

3.1.1 Frequency Range: 5.4 to 5.9 GHz

3.1.2 Trigger Sensitivity: -65 dBm minimum

3.1.3 Peak Power Output: 400 watts minimum

3.1.4 Standard Reply Delay: 2.5 microseconds selectable

3.1.5 Interrogation Pulse Coding: Double pulse

3.1.6 Pulse Repetition Frequency Response Range: 0 to 2600 pps

3.1.7 Recovery Time: 50 microseconds maximum

3.1.8 Nominal Operating Voltage: 24 to 32 Vdc

3.1.9 Operating Stabilization Time: 3 minutes

3.2 **Receiver/Decoder Characteristics**

3.2.1 Design Type: Superheterodyne

3.2.2 Frequency Range: 5.4 to 5.9 GHz

3.2.3 Receiver Tuning: Single local oscillator tuning control and 3 preselector tuning controls accessible from exterior of unit

3.2.4 Frequency Stability: ±2 MHz after 3 minute warmup

3.2.5 3 dB Bandwidth: 11 ±3 MHz

3.2.6 40 dB Bandwidth: 90 MHz typical

3.2.7 Off-Frequency and Image Rejection: Image rejection, 60 dB minimum

3.2.8 Dynamic Signal Range: +20 to -65 dBm

3.2.9 Maximum Input Signal: +20 dBm

3.2.10 Pulse Width Acceptance: 0.25 to 1.0 microsecond

3.2.11 Pulse Rise Time Acceptance: 0.1 microsecond or less

3.2.12 Pulse Code Spacing: 3.0 to 12.0 microseconds selectable

3.2.13 Decoder Accept Limits: ±0.15 microsecond

3.2.14 Decoder Reject Limits: ±0.30 microsecond

3.2.15 Delay Decision Pulse Trigger Point (Percent of rise time): Not specified

3.3 **Transmitter Characteristics**

3.3.1 Design Type: Magnetron

3.3.2 Frequency Range: 5.4 to 5.9 GHz

3.3.3 Transmitter Tuning: Single control accessible from exterior of unit

3.3.4 Frequency Stability: ±3.0 MHz under all conditions except temperature. During changes in ambient temperature, frequency drift will not exceed 50 kHz/°C.

3.3.5 Peak Power Output: 400 watts minimum

3.3.6 Power Spectrum: The RF bandwidth in MHz will not exceed 3.0/pulse width in microseconds measured at the quarter power point.

3.3.7 Spectral Purity: Spectrum nulls typically down 11 dB from peak

3.3.8 Spurious Radiation: None below transmitter second harmonic

3.3.9 Pulse Repetition Rate Range: 0 to 2600 pulses per second

3.3.10 Duty Cycle: 0.002 maximum

3.3.11 Pulse Width: 0.5 ±0.1 microsecond

3.3.12 Pulse Width Jitter: 0.01 microsecond maximum

3.3.13 Pulse Amplitude Variation: Not specified

3.3.14 Pulse Rise Time (10 to 90 percent): 0.1 microsecond maximum

3.3.15 Pulse Fall Time (90 to 10 percent): 0.2 microsecond maximum

3.4 **Delay Characteristics**

3.4.1 Absolute System Delay Variation: Not specified

3.4.2 Reply Delay Variations

3.4.2.1 Signal Strength Variation: ±0.02 microsecond from 0 to -65 dBm

3.4.2.2 Interrogation Rate Variation: Not specified

3.4.2.3 Interrogation Frequency variation: Not specified

3.4.2.4 Pulse Code Spacing Variation: Not specified

3.4.2.5 Decision Pulse Rise Time Variation: Not specified

3.4.2.6 Input Power Potential Variation: Not specified

3.4.2.7 Acceleration Variation: Not specified

3.4.3 Reply Delay Jitter: Will not exceed 0.02 microsecond peak to peak for input signal levels of 0 to -55 dBm. Will not exceed 0.05 microsecond peak to peak for input signal levels of -55 to -65 dBm.

3.5 **Radio Frequency Load Matching Characteristics**

3.5.1 Input Impedance: 50 ohm nominal

3.5.2 Output Impedance: 50 ohm nominal

3.5.3 Open/Short Survival: Transmitter shall meet all requirements after application and removal of either a short or open circuit at the antenna terminal.

3.5.4 Voltage Standing Wave Ratio of Load: Will operate in conjunction with an antenna system having a VSWR of 2.5:1 at all phase angles.

3.5.5 Duplexer Type: Four-port ferrite circulator

3.6 **Power Supply Characteristics**

3.6.1 Design Type: Primary regulated dc-dc converter

3.6.2 Input Voltage Range: 24 to 32 Vdc

3.6.3 Under Voltage/Over Voltage Protection: Not specified

3.6.4 Input Current, Quiescent: 0.5 ampere maximum

3.6.5 Input Current, Interrogated at 1000 pulses per second: 0.8 ampere at 28 Vdc

3.6.6 Transient Protection: MIL-E-26144

3.6.7 Grounding and Isolation: Input power lines isolated from chassis ground

3.6.8 Standby Operation: Same as quiescent

3.7 **Design Characteristics**

3.7.1 Response to Valid Interrogations: Shall trigger at least 99 percent replies to signals at level between 0 to -65 dBm applied to the transponder antenna connector

3.7.2 Random Triggering: Will not exceed 10 pulses per second under any operating conditions

3.7.3 Transmitter-Receiver Frequency Separation: 50 MHz minimum

3.7.4 Off-Band Rejection Filter: Three-section preselector and tuned IF amplifier

3.7.5 Mixer Diode Protection: Preselector protects diode from off-frequency RF

3.7.6 Power Delay Time: 30 seconds typical

3.7.7 Reverse Polarity Protection: Provided to prevent permanent damage upon application of reverse polarity voltage of up to 50 Vdc on the 28 Vdc line

3.7.8 Over-Interrogation Protection: Provided to limit transmission rate to 3300 pulses per second

3.7.9 Lock-Out Protection: Provides for no response during 50 microseconds recovery time of transponder

3.8 **Environmental Specifications**

3.8.1 Operating Temperature: +27°C to +63°C (+45°F to +145°F)

3.8.2 Nonoperating Temperature: -38°C to +71°C (-37°F to +160°F)

3.8.3 Pressure Altitude: 760 mm to 0.17 mm of mercury, 200,000 feet for 30 minutes

3.8.4 Shock:

Nonoperating

Four shocks per axis applied at the mounting points consisting of terminal peak sawtooth shocks of 0.25 second duration

Operating Shock Response Spectrum

Shock applied to both directions along each of three mutually perpendicular axis for a total of six shocks

Frequency (Hz)	Response Amplitude (G)
10	24
15	26
35	60
100	82
400	900
900	1200
5000	900

3.8.5 Sine Vibration: Not specified

3.8.6 Random Vibration:

Nonoperating

Load applied along any axis for 20 minute duration

Frequency (Hz)	Amplitude or Slope
1.0	*0.006 PSD
5-10	0.025 PSD
20.0	*0.012 PSD
49-500	0.001 PSD

*Slope is defined by corner points 9.96g 20 minutes one axis

Operating

Powered Flight

Frequency (Hz)	PSD (um)
10.0	*0.0045
450.0	*0.0280
2000.0	*0.1100

*Slope is defined by corners 3 minutes/axis 13.0g

Reentry

Frequency (Hz)	PSD
20.0	0.07
20-36	*
36-2000	0.40
2000-4000	*
4000	0.10

*Slope is defined by corners 20 seconds/axis 34.4g

3.8.7 Acoustical Noise: Not specified

3.8.8 Random Noise: Not specified

3.8.9 Acceleration:

Linear

-77g in the longitudinal axis with 315g in any lateral axis and -100g in the longitudinal axis with no acceleration in any lateral axis Minimum of 20 seconds

Angular Motion

Nonoperating

5.2g each direction of 3 axis for 2 minutes minimum

Operating

10g each direction of 3 axis for 2 minutes minimum

Spin

8300°/second for 20 seconds minimum, 5.36 inches from spin axis (291.4g)

3.8.10 Humidity: MIL-STD-810C, Method 507.1, Procedure I

3.8.11 Salt Fog Atmosphere: Not specified

3.8.12 Rain: Not specified

3.8-13 Sand and Dust: Not specified

3.8.14 Fungus: Not specified

3.8.15 Missile Fuel Compatibility: Not specified

3.8.16 Electromagnetic Compatibility: MIL-STD-461B, Class A2, Methods CE03, CE06, CE07, CS01, CS02, CS03, CS05, CS06, RE02, RS02, and RS03

3.9 **Physical/Mechanical Characteristics**

3.9.1 Form: Rectangular solid

3.9.2 Dimensions, Excluding Protrusions: 4.83 x 3.93 x 2.90 inches

3.9.3 Displacement Volume: 45 cubic inches

3.9.4 Weight: 48 ounces maximum

3.9.5 Pressurization: Not specified

3.9.6 Mounting Attitude: Any

3.9.7 Mounting Dimensions: 4 mounting holes 0.22 inch diameter

3.9.8 Power and Test Connector: JTL07H1O-98P (MIL-C-38999 Compatible)

3.9.9 Radio Frequency Connector: TNC female (MIL-C-39012)

3.9.10 Type of External Controls: None

3.9.11 Pressurization Fitting Type: Not specified

3.9.12 Grounding and Bonding: Not necessary

3.9.13 Mounting Bracket: Not specified

3.9.14 Mounting Type: Not specified

3.10 **Auxiliary Functions**

3.10.1 External Output Signal Provisions: Not specified

3.10.2 External Input Signal Provisions: Not specified

3.10.3 External Adjustments: Transmitter tuning and receiver tuning

3.10.4 External Test Points: Not specified

3.10.5 Internal Test Points: Provided to allow rapid isolation of malfunction to a particular module

3.11 **Coherent Velocity Specifications**

3.11.1 Pulse Coherence Doppler Error: Not applicable

3.11.2 Dynamic Signal Strength Range: Not applicable

3.11.3 Spectral Skew: Not applicable

3.11.4 Carrier Line Width: Not applicable

3.11.5 Interline Noise: Not applicable

3.11.6 Frequency Locking Range: Not applicable

4.0 **QUALITY/RELIABILITY DATA**

4.1 **Reliability Characteristics**

4.1.1 Design Reliability: 0.999996 launch and flight reliability

4.1.2 Operational Stability: 500 hours

4.1.3 Service Life: Unlimited with minimal servicing and replacement of parts

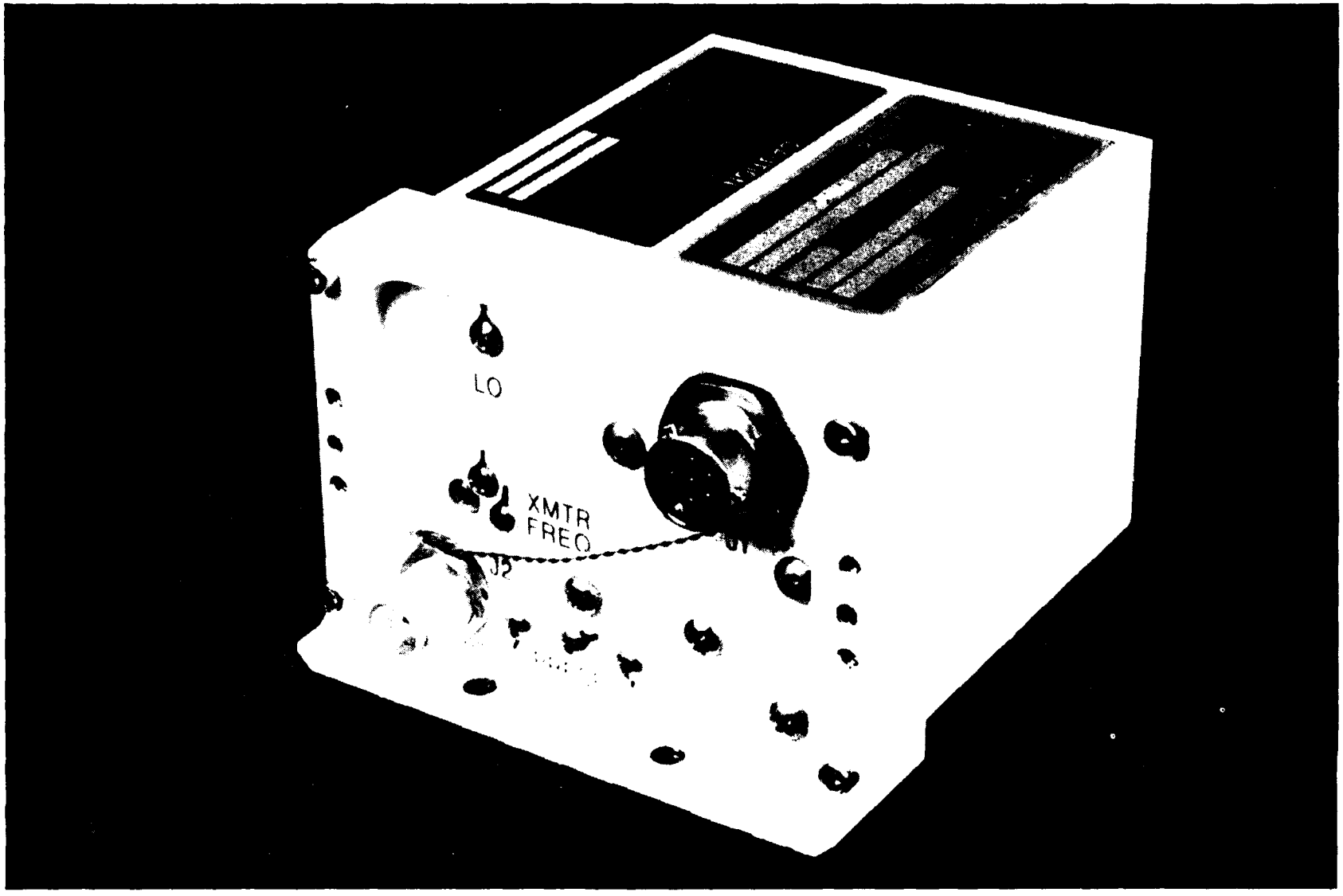

Figure 1-5. Model RT385 Transponder.

VEGA PRECISION LABORATORIES
G-BAND NONCOHERENT RADAR TRANSPONDER SET

Manufacturer's Model Designation:	**6156-1**
Manufacturer's Part Number:	**406633-1**
Military Designation:	**AN/DKW-4(V)2**
Federal Stock Number:	**5895-01-254-1475**

1.0 GENERAL DESCRIPTION

The AN/DKW-4(V)2 Transponder Set provides command and control capability, position data, and telemetry data for unmanned aerial vehicles and targets when used with the Vega model 6157-1 Portable Radar Tracking and Control System (PRTCS). Two modes of operation, Command and Track, are available. In the command mode, pulse-position-code (PPC) interrogations are transmitted by the PRTCS. This five-pulse group is received and decoded by the transponder set and commands are output to the vehicle. The transponder set outputs a four-pulse telemetry group to the PRTCS. The transponder set can simultaneously respond to command mode and track mode interrogations and output both 4-pulse and 2-pulse coded PPC.

2.0 DEVELOPMENT AND UTILIZATION

The AN/DKW-4(V)2 Transponder Set was developed by Vega under contract with the U.S. Navy.

3.0 TECHNICAL SPECIFICATIONS

3.1 General Characteristics

3.1.1 Frequency Range: 5400 to 5900 MHz tunable

3.1.2 Trigger Sensitivity: -80 dBm minimum

3.1.3 Peak Power Output: 600 watts minimum

3.1.4 Standard Reply Delay: 4.0 ±0.1 microsecond

3.1.5 Pulse Coding

3.1.5.1 Interrogation Pulse Coding
Command Mode: five-pulse, pulse-position-code format
Track Mode: two-pulse

3.1.5.2 Reply Pulse Code
Command Mode: telemetry, four-pulse, pulse-position-code format
Track Mode: two-pulse

3.1.6 Pulse Repetition Frequency Response Range: 1280 pulses per second minimum, 4160 pulses per second maximum

3.1.7 Recovery Time: 9 microsecond maximum

3.1.8 Nominal Operating Voltage: 22 to 29 Vdc

3.1.9 Operating Stabilization Time: 3 minutes

3.2 **Receiver/Decoder Characteristics**

3.2.1 Design Type: Superheterodyne

3.2.2 Frequency Range: 5400 to 5900 MHz tunable

3.2.3 Receiver Tuning: Single local oscillator tuning control and five preselector tuning controls

3.2.4 Frequency Stability: ±5 MHz

3.2.5 3 dB Bandwidth: 13 ±5 MHz

3.2.6 40 dB Bandwidth: Not specified

3.2.7 Off-Frequency and Image Rejection: Not specified

3.2.8 Dynamic Signal Range: +20 to -80 dBm

3.2.9 Maximum Input Signal: +20 dBm

3.2.10 Pulse Width Acceptance: Pulse Width Discriminator, 0.20 0.60 ±0.05 microsecond for signal levels 0 to -67 ±3 dBm

3.2.11 Pulse Rise Time Acceptance: Pulse Amplitude Discriminator varies inversely with AGC level

3.2.12 Pulse Code Spacing
Command Mode: five-pulse, pulse-position-code format
Track Mode: two-pulse

3.2.13 Decoder Accept Limits: Not applicable

3.2.14 Decoder Reject Limits: Not applicable

3.2.15 Delay Decision Pulse Trigger Point (Percent of rise time): Not specified

3.3 **Transmitter Characteristics**

3.3.1 Design Type: Magnetron

3.3.2 Frequency Range: 5400 to 5900 MHz tunable

3.3.3 Transmitter Tuning: Single control

3.3.4 Frequency Stability: ±6 MHz

3.3.5 Peak Power Output: 600 watts minimum

3.3.6 Power Spectrum: The RF bandwidth in MHz will not exceed 3.0/pulse width in microseconds measured at the quarter power point.

3.3.7 Spectral Purity: Not specified

3.3.8 Spurious Radiation: Not specified

3.3.9 Pulse Repetition Rate Range: 1280 pulses per second minimum, 4160 pulses per second maximum

3.3.10 Duty Cycle: 0.0015 maximum

3.3.11 Pulse Width: 0.3 ±0.1 microsecond

3.3.12 Pulse Width Jitter: ±0.1 microsecond pulse-to-pulse

3.3.13 Pulse Amplitude Variation: Not specified

3.3.14 Pulse Rise Time (10 to 90 percent): 0.1 microsecond maximum

3.3.15 Pulse Fall Time (90 to 10 percent): 0.2 microsecond maximum

3.4 **Delay Characteristics**

3.4.1 Absolute system Delay Variation: Not specified

3.4.2 Reply Delay Variations

3.4.2.1 Signal Strength Variation: Not specified

3.4.2.2 Interrogation Rate Variation: Not specified

3.4.2.3 Interrogation Frequency Variation: Not specified

3.4.2.4 Pulse Code Spacing Variation: Not specified

3.4.2.5 Decision Pulse Rise Time Variation: Not specified

3.4.2.6 Input Power Potential Variation: Not specified

3.4.2.7 Acceleration Variation: Not specified

3.4.3 Reply Delay Jitter: Not specified

3.5 **Radio Frequency Load Matching Characteristics**

3.5.1 Input Impedance: 50 ohm nominal

3.5.2 Output Impedance: 50 ohm nominal

3.5.3 Open/Short Survival: Transmitter shall meet all requirements after application and removal of either a short or open circuit at the antenna terminal.

3.5.4 Voltage Standing Wave Ratio of Load: Operate into VSWR of 1.5:1 at all phase angles.

3.5.5 Duplexer Type: Four-port ferrite circulator

3.6 **Power Supply Characteristics**

3.6.1 Design Type: Primary regulated dc-dc converter

3.6.2 Input Voltage Range: 22 to 29 Vdc

3.6.3 Under Voltage/Over Voltage Protection: Not specified

3.6.4 Input Current, Quiescent: Not specified

3.6.5 Input Current, Interrogated at 1000 pulses per second: 4.0 ampere maximum

3.6.6 Transient Protection: MIL-STD-704

3.6.7 Grounding and Isolation: Input power lines isolated from chassis ground

3.6.8 Standby Operation: Not specified

3.7 **Design Characteristics**

3.7.1 Response to Valid Interrogations: Shall trigger at least 99 percent replies to signals at level of -80 to +20 dBm in the specified command mode or track mode format

3.7.2 Random Triggering: Not specified

3.7.3 Transmitter-Receiver Frequency Separation: 50 MHz minimum

3.7.4 Off-Band Rejection Filter: Five-section preselector and tuned IF amplifier

3.7.5 Mixer Diode Protection: Preselector protects mixer diode from off-frequency RF. An AGC attenuator and limiter protect receiver front end from large RF signals

3.7.6 Power Delay Time: 60 seconds

3.7.7 Reverse Polarity Protection: Provided on 28 Vdc power line

3.7.8 Over-Interrogation Protection: Provided to limit transmitter duty cycle to less than 0.0015

3.7.9 Lock-Out Protection: Not specified

3.8 **Environmental Specifications**

3.8.1 Operating Temperature: -40°C to +55°C (-40°F to +131°F)

3.8.2 Nonoperating Temperature: -57°C to +85°C (-71°F to +185°F)

3.8.3 Pressure Altitude: Sea level to 50,000 feet

3.8.4 Shock: MIL-STD-810D, Method 516.3, Procedure I (15g for 11 milliseconds)

3.8.5 Sine Vibration: MIL-STD-810D, Method 514.3, Category 5 (20 to 2000 Hz, 5g)

3.8.6 Random Vibration: MIL-STD-810D, Method 514.3, Category 5 (7.6g)

3.8.7 Acoustical Noise: Not specified

3.8.8 Random Noise: Not specified

3.8.9 Acceleration: MIL-STD-810D, Method 513.3, Procedure II

3.8.10 Humidity: Not specified. Submergence per MIL-STD-810D, Method 512.2, Procedure I, 3 feet

3.8.11 Salt Fog Atmosphere: MIL-STD-810D, Method 509.2, Procedure II

3.8.12 Rain: Not specified. Submergence per MIL-STD-810D, Method 512.2, Procedure I, 3 feet

3.8.13 Sand and Dust: Not specified

3.8.14 Fungus: Not specified

3.8.15 Missile Fuel Compatibility: Not specified

3.8.16 Electromagnetic Compatibility: MIL-STD-461B, Methods CE06, CS02, CS04, RS02, RS03, CE03, and RS02

3.9 **Physical/Mechanical Characteristics**

3.9.1 Form: Rectangular solid

3.9.2 Dimensions, Excluding Protrusions: 10.65 x 7.93 x 4.06 inches

3.9.3 Displacement Volume: Not specified

3.9.4 Weight: 12 pounds maximum

3.9.5 Pressurization: Not specified

3.9.6 Mounting Attitude: Any

3.9.7 Mounting Dimensions: 4 holes 0.164-32 UNC x 0.28 deep at the corners of a square 4.600 x 9.200 inches on top and bottom surfaces

3.9.8 Power and Test Connector

Power Connector:	MS3114H12C-10P (mates with MS3116F12-10S)
Telemetry Connector:	MS3114H18C-32S (mates with MS3116F18-32P)
Command Connector:	MS3114H22C-55P (mates with MS3116F22-55S)

3.9.9 Radio Frequency Connector: N female (2)

3.9.10 Type of External Controls: TCT Address, TRK Address

3.9.11 Pressurization Fitting Type: Adapter through front panel access screw

3.9.12 Grounding and Bonding: Not necessary

3.9.13 Mounting Bracket: Not specified

3.9.14 Mounting Type: Not specified

3.10 **Auxiliary Functions**

3.10.1 External Output Signal Provisions (Commands)
Proportional: (2) 8-Bit, Standard TTL output drive
Discrete: (24) Active-on, Standard TTL output drive

3.10.2 External Input Signal Provisions (Telemetry)
Proportional: (12) 0 to 5 Vdc input with 10-bit resolution, 500K input impedance
Discrete: (12) TTL-Compatible inputs with ON/OFF resolution, 20K input impedance

3.10.3 External Adjustments: TCT Address, TRK Address

3.10.4 External Test Points: Not specified

3.10.5 Internal Test Points: Provided to allow rapid isolation of malfunction to a particular module

3.11 **Coherent Velocity Specifications**

3.11.1 Pulse Coherence Doppler Error: Not applicable

3.11.2 Dynamic Signal Strength Range: Not applicable

3.11.3 Spectral Skew: Not applicable

3.11.4 Carrier Line Width: Not applicable

3.11.5 Interline Noise: Not applicable

3.11.6 Frequency Locking Range: Not applicable

4.0 **QUALITY/RELIABILITY DATA**

4.1 **Reliability Characteristics**

4.1.1 Design Reliability: A parts count prediction per MIL-HDBK-217, Revision E, indicates an MTBF of 2856 hours

4.1.2 Operational Stability: 450 hours

4.1.3 Service Life: 5000 hours minimum with minimal servicing and replacement of parts

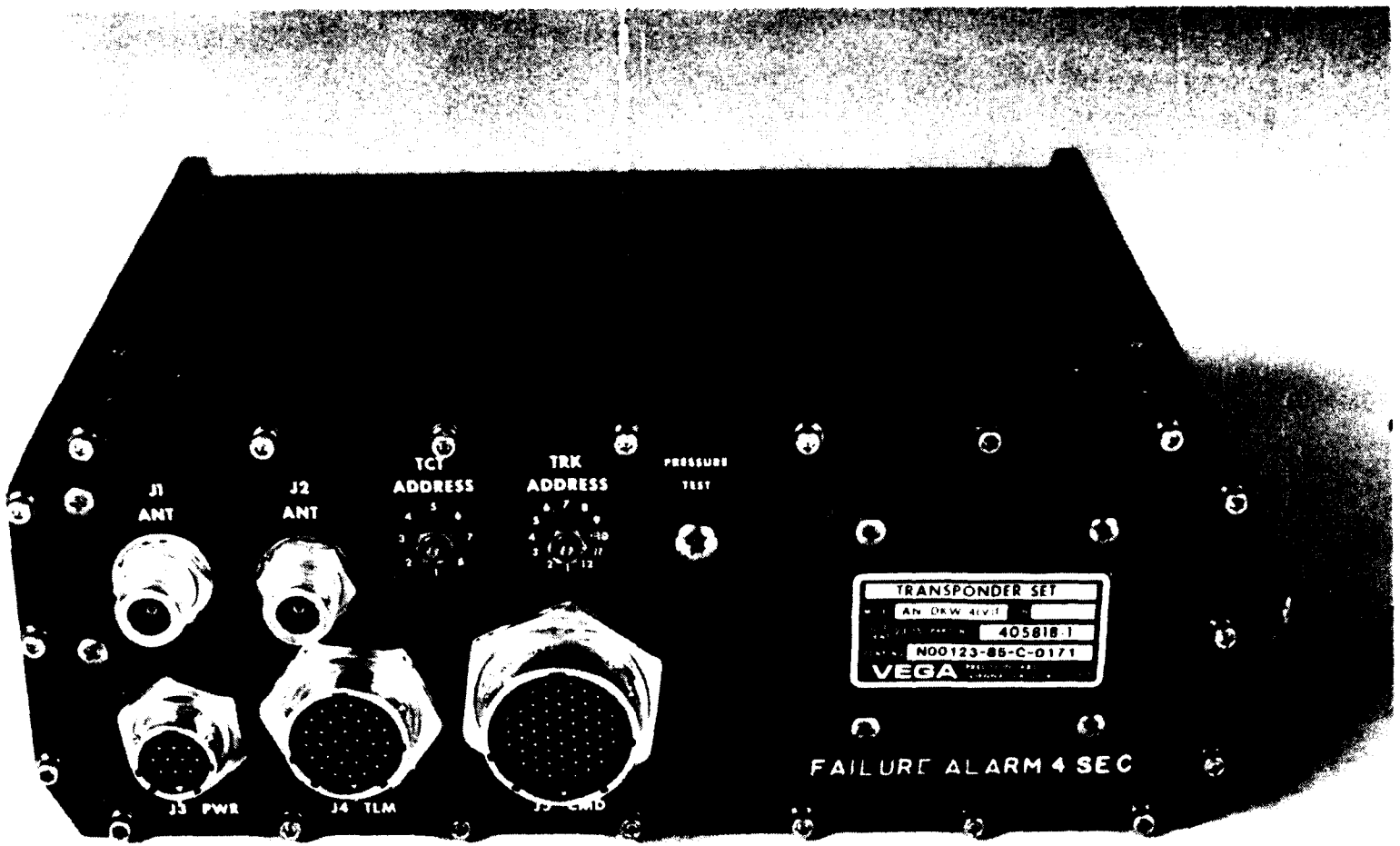

Figure 1-7. Model 6156-1 Target Control Transponder.

2. HERLEY INDUSTRIES, INC.
10 INDUSTRY DRIVE
LANCASTER, PENNSYLVANIA
PHONE: (717) 397-2777

C-BAND RADAR TRACKING TRANSPONDERS

Model MD50C-1
Model MD50C-2
Model MD400C-1
Model MD401C-1
Model MD401C-2

HERLEY INDUSTRIES, INC.
C-BAND RADAR TRACKING TRANSPONDER

Manufacturer's Model Designation: **MD50C-1**
Manufacturer's Part Number: **500001**
Military Designation:
Federal Stock Number:

1.0 GENERAL DESCRIPTION

The model MD50C-1 is a general purpose, precision C-band radar augmentation device with a high sensitivity superheterodyne receiver and triode cavity oscillator transmitter. Used primarily for range safety functions, the model MD50C-1 is suitable for use in both manned and unmanned vehicles. This transponder is applicable to precision tracking of aircraft, sounding rockets, space-launch vehicles, missiles, decoys, and target drones both sea and airborne. This unit is fully tuneable over the 5.4 to 5.9 GHz range, while being quite small in size (less than 30 cubic inches) and lightweight (less than 26 ounces), thus making it suitable for use in applications requiring very small sizes with moderate power. Environmental requirements are to MIL-STD-810.

2.0 DEVELOPMENT AND UTILIZATION

The model MD50C-1 was developed by Herley Industries, Inc. with company funds to fill the need for a rugged, precision radar transponder, whose modern circuitry greatly improves reliability and performance. The model MD50C-1 is a family of transponders with many minor variations to suit each customer's unique system requirements. This model has been qualified by White Sands Missile Range, New Mexico. It is being used on such programs as NASA's sounding rockets, AMRAAM, AAAM, ITALD, and CL227 at numerous facilities and numerous missile applications at WSMR.

3.0 TECHNICAL SPECIFICATIONS

3.1 General Characteristics

3.1.1 Frequency Range: 5.4 to 5.9 GHz

3.1.2 Trigger Sensitivity: -65 dBm minimum for 99 percent reply

3.1.3 Peak Power Output: 50 watts minimum

3.1.4 Standard Reply Delay: 2.0 to 6.0 microseconds

3.1.5 Interrogation Pulse Coding: 3.0 to 12.0 microseconds

3.1.6 Pulse Repetition Frequency Response Range: 2600 pps nominal

3.1.7 Recovery Time: 50 microseconds minimum

3.1.8 Nominal Operating Voltage: 22 to 32 Vdc

3.1.9 Operating Stabilization Time: 3 minutes maximum

3.2 **Receiver/Decoder Characteristics**

3.2.1 Design Type: Superheterodyne

3.2.2 Frequency Range: 5.4 to 5.9 GHz

3.2.3 Receiver Tuning: Mechanical (4 screws)

3.2.4 Frequency Stability: ±5.0 MHz after a 3 minute warmup

3.2.5 3 dB Bandwidth: 11.0 ±5.0 MHz

3.2.6 40 dB Bandwidth: Not specified

3.2.7 Off-Frequency and Image Rejection: 60 dB minimum

3.2.8 Dynamic Signal Range: +10 to -65 dBm

3.2.9 Maximum Input Signal: +10 dBm

3.2.10 Pulse Width Acceptance: 0.25 to 5.0 microseconds in single pulse mode, 0.25 to 1.0 microsecond in the double pulse mode.

3.2.11 Pulse Rise Time Acceptance: 0.100 microsecond

3.2.12 Pulse Code Spacing Range: 3.0 to 12.0 microseconds

3.2.13 Decoder Accept Limits: ±0.150 microsecond

3.2.14 Decoder Reject Limits: ±0.300 microsecond

3.2.15 Delay Decision Pulse Trigger Point (Percent of rise time): 50 percent

3.3 **Transmitter Characteristics**

3.3.1 Design Type: Tiode cavity oscillator

3.3.2 Frequency Range: 5.4 to 5.9 GHz

3.3.3 Transmitter Tuning: Mechanical (1 screw)

3.3.4 Frequency Stability: ±3.0 MHz plus ±50 KHz/°C maximum

3.3.5 Peak Power Output: 50 watts minimum

3.3.6 Power Spectrum: Bandwidth (MHz) is less than 3.0/pulse width (in microseconds) measured at the 1/4 power level points.

3.3.7 Spectral Purity: First side lobes 7 dB below peak main lobe minimum. First nulls 9 dB below peak main lobe minimum.

3.3.8 Spurious Radiation: Not specified

3.3.9 Pulse Repetition Rate Range: 2600 pps nominal

3.3.10 Duty Cycle: Up to 0.002 (0.2 percent)

3.3.11 Pulse Width: 0.5 ±0.1 microsecond

3.3.12 Pulse Width Jitter: 0.01 microsecond maximum

3.3.13 Pulse Amplitude Variation: Not specified

3.3.14 Pulse Rise Time: 0.100 microsecond maximum

3.3.15 Pulse Fall Time: 0.200 microsecond maximum

3.4 **Delay Characteristics**

3.4.1 Absolute System Delay Variation: Not specified

3.4.2 Reply Delay Variations

3.4.2.1 Signal Strength Variation: 0.03 microsecond maximum for input signals between 0 and -60 dBm

3.4.2.2 Interrogation Rate Variation: 0.016 microsecond maximum for prf from 160 to 2600 pps

3.4.2.3 Interrogation Frequency Variation: 0.01 microsecond typical for ±3.0 MHz

3.4.2.4 Pulse Code Spacing Variation: 0.05 microsecond typical for code space variations of ±0.15 microsecond

3.4.2.5 Decision Pulse Rise Time Variation: 0.02 microsecond maximum

3.4.2.6 Input Power Potential Variation: 0.01 microsecond maximum

3.4.2.7 Temperature Variation: 0.01 microsecond maximum from a nominal delay at 80.6°F (27°C) and 0 dBm input for temperatures ranging from -18°F (-28°C) to +156°F (+69°C) and 0.02 microsecond maximum for temperatures ranging from -65.2°F (-54°C) to +185°F (+85°C)

3.4.2.8 Acceleration Variation: Not specified

3.4.3 Reply Delay Jitter: 0.02 microsecond maximum peak to peak for 0 dBm to -55 dBm, and 0.05 microsecond maximum peak to peak for -55 dBm to -65 dBm

3.5 **Radio Frequency Load Matching Characteristics**

3.5.1 Input Impedance: 50 ohm

3.5.2 Output Impedance: 50 ohm

3.5.3 Open-Short Survival: Built in to provide antenna mismatch protection

3.5.4 Voltage Standing Wave Ratio of the Load: 2:1 maximum

3.5.5 Duplexer Type: Four-port circulator

3.6 **Power Supply Characteristics**

3.6.1 Design Type: Series pass regulator with chopper

3.6.2 Input Voltage Range: 22 to 32 Vdc

3.6.3 Under Voltage/Over Voltage Protection: Normal regulation to 20.5 volts input/higher voltage components used

3.6.4 Input Current, Quiescent: 0.250 amp nominal

3.6.5 Input Current, Interrogated at 1000 pps: 0.300 amp nominal

3.6.6 Transient Protection: Provided by regulator portion of power supply

3.6.7 Grounding and Isolation: Power leads isolated from chassis by 1 meg ohm minimum

3.6.8 Standby Operation: None

3.7 **Design Characteristics**

3.7.1 Response to Valid Interrogation: Better than 99 percent for all valid interrogations

3.7.2 Random Triggering and Free Running: Less than 10 pps under all conditions

3.7.3 Transmitter-Receiver Frequency Separation: 50 MHz minimum

3.7.4 Off-Band Rejection Filter: Provided with the three section preselector

3.7.5 Mixer Diode Protection: Limited to +20 dBm input

3.7.6 Power Delay Time: 45 seconds nominal

3.7.7 Reverse Polarity Protection: Provided with series diode

3.7.8 Over-Interrogation Protection: Provided with internal integrator circuit

3.7.9 Lock-Out Protection: Receiver blanked for 50 microseconds maximum during transmit time

3.8 **Environmental Specifications**

3.8.1 Operating Temperature: -54°C (-66°F) to +75°C (+167°F)

3.8.2 Nonoperating Temperature: -62.2°C (-80°F) to +75°C (+167°F)

3.8.3 Pressure Altitude: 760 mm of mercury (sea level) to 0.04 mm of mercury (230,000 feet altitude)

3.8.4 Shock: 150g sawtooth for 4 milliseconds duration, operating.

3.8.5 Sine Vibration: 5 to 10 Hz, 0.20 inch double amplitude; 10 to 18 Hz, 1g; 18 to 81 Hz, 0.06 inch double amplitude; 81 to 2000 Hz, 20g

3.8.6 Random Vibration: $0.0008g^2$ rms/Hz at 20 Hz, increasing at 6 dB/octave, to $0.20g^2$ rms/Hz at 100 Hz; 16.9g rms from 100 to 1000 Hz; decreasing at 6 dB/octave from $0.20g^2$ rms/Hz at 1000 Hz, to $0.05g^2$ rms/Hz at 2000 Hz

3.8.7 Acoustical Noise: Not specified

3.8.8 Random Noise: Not specified

3.8.9 Acceleration: 30g applied along any axis for 1 minute

3.8.10 Humidity: Any, up to 100 percent including condensation because of temperature changes

3.8.11 Salt Fog Atmosphere: Not specified

3.8.12 Rain: Not specified

3.8.13 Sand and Dust: Not specified

3.8.14 Fungus: Not specified

3.8.15 Missile Fuel Compatibility: Not specified

3.8.16 Electromagnetic Interference: Methods CE03, CS02, CS03, CS04, RE02, RE03, RS02, and RS03 of MIL-STD 461

3.9 **Physical/Mechanical Characteristics**

3.9.1 Form: Rectangular

3.9.2 Dimensions, Excluding Protrusions: 4.25L X 3.50W X 2.00H (10.80 X 8.89 X 5.08 cm)

3.9.3 Displacement Volume: 25 cubic inches (405 cubic cm) nominal

3.9.4 Weight: 26 ounces (0.74 kgm) maximum

3.9.5 Pressurization: Sealed at sea level

3.9.6 Mounting Attitude: Any

3.9.7 Mounting Dimensions: 6 holes, 3 in each line spaced 1.050 inches to either side of the center with the lines separated by 3.200 inches. Clearance holes for #8 screws.

3.9.8 Power and Test Connector Type: MS27476Y08D35P (mates with MS27476Y08D35S)

3.9.9 Radio Frequency Connector Type: SMA female

3.9.10 Type of External Controls: Slotted screwdriver adjust with removal of a seal screw

3.9.11 Pressurization Fitting Type: Schraeder valve mounted on unit

3.9.12 Grounding and Bonding: Entire case at ground potential

3.9.13 Mounting Bracket: None

3.9.14 Mounting Type: Provision for six #8 screws

3.10 **Auxiliary Functions**

3.10.1 External Output Signal Provisions: TM connector providing a pulse concident with the second received uplink pulse

3.10.2 External Input Signal Provisions: None

3.10.3 External Adjustments: Receiver tune, transmitter tune (provided with removal of a seal screw)

3.10.4 External Test Points: None

3.10.5 Internal Test Points: Provided for easy signal tracing

3.11 **Coherent Velocity Specifications**

3.11.1 Pulse Coherence Doppler Error: Not applicable

3.11.2 Dynamic Signal Strength Range: Not applicable

3.11.3 Spectral Skew: Not applicable

3.11.4 Carrier Line Width: Not applicable

3.11.5 Interline Noise: Not applicable

3.11.6 Frequency Locking Range: Not applicable

4.0 **QUALITY/RELIABILITY DATA**

4.1 **Reliability Characteristics**

4.1.1 Design Reliability: The mean time between failures (MTBF) is greater than 30 hours at a 90 percent confidence level

4.1.2 Operational Stability:

4.1.3 Service Life: Not specified

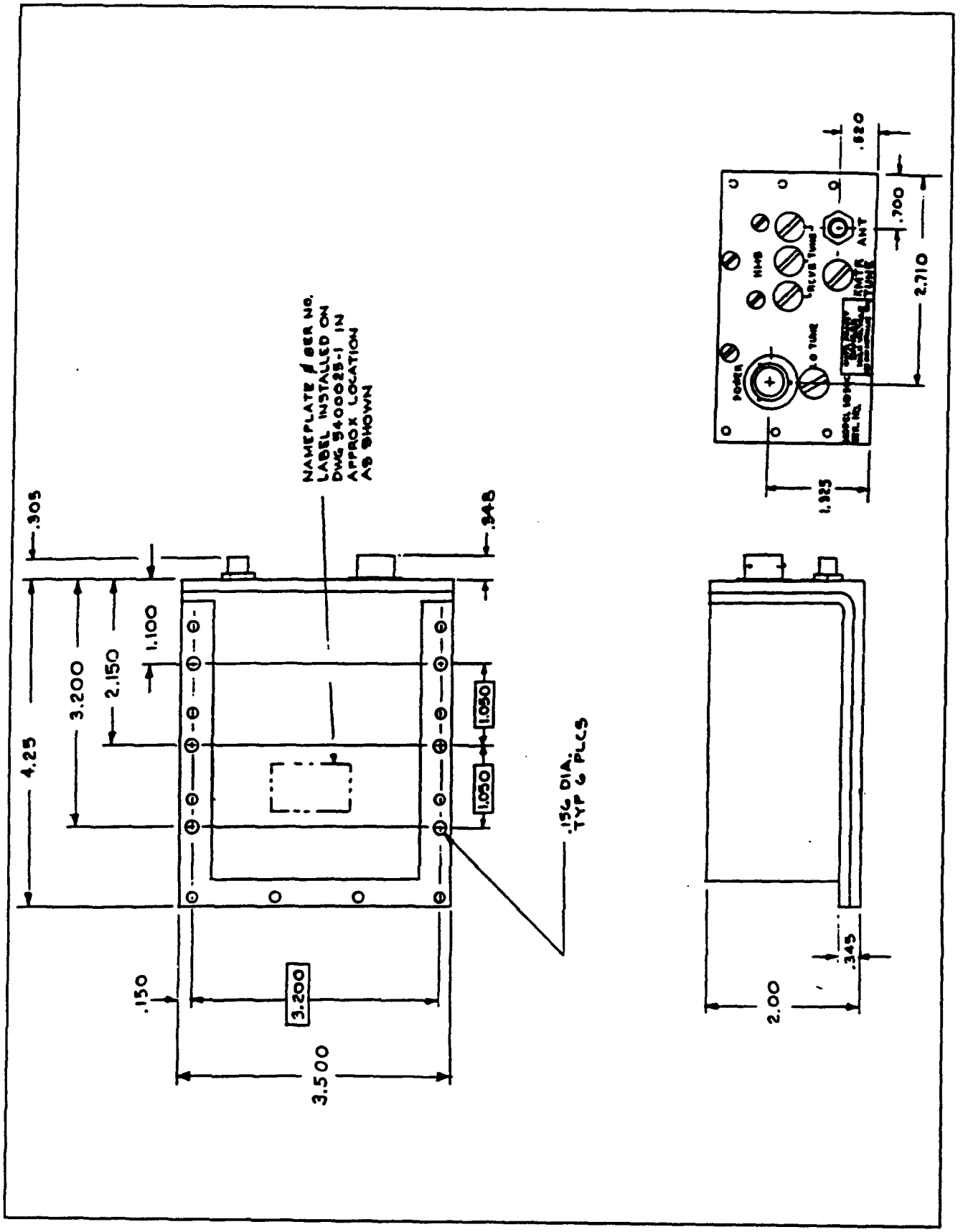

Figure 2-1. MD50C outline drawing - all versions.

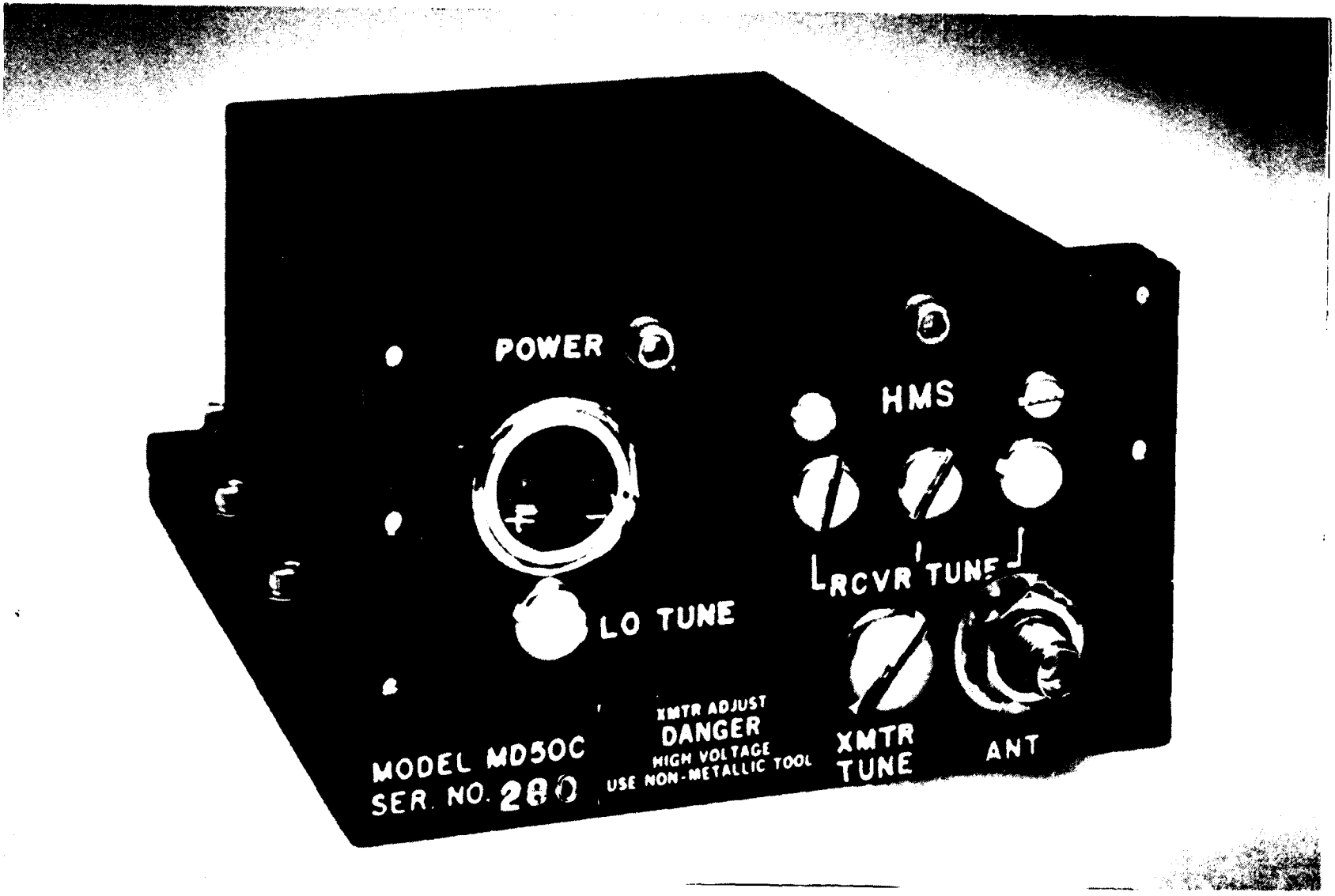

Figure 2-2. Model MD50C-1 C-Band Radar.

HERLEY INDUSTRIES, INC.
C-BAND RADAR TRACKING TRANSPONDER

Manufacturer's Model Designation:	**MD50C-2**
Manufacturer's Part Number:	**500001-2**
Military Designation:	**None**
Federal Stock Number:	**None**

1.0 GENERAL DESCRIPTION

The model MD50C-1 is a general purpose, precision C-band radar augmentation device with a high sensitivity superheterodyne receiver and triode cavity oscillator transmitter. Used primarily for range safety functions, while the model MD50C-2 is suitable for use in both manned and unmanned vehicles. This transponder is applicable to precision tracking of aircraft, sounding rockets, space-launch vehicles, missiles, decoys, and target drones both sea and airborne. This unit is fully tuneable over the 5.4 to 5.9 GHz range, while being quite small (less than 30 cubic inches) and lightweight (less than 26 ounces), making it suitable for use in applications requiring very small size with moderate power. Environmental requirements are to MIL-STD-810.

2.0 DEVELOPMENT AND UTILIZATION

The model MD50C-2 was developed by Herley Industries, Inc. with company funds to fill the need for a rugged, high reliability, precision radar transponder, whose modern circuitry and screened parts greatly improve reliability and performance. The model MD50C is a family of transponders with many minor variations to suit each customer's unique system requirements. The model MD50C has been qualified by White Sands Missile Range, New Mexico. It is being used on such programs as NASA's sounding rockets, AMRAAM, AAAM, ITALD, and CL227 at numerous facilities and numerous missile applications at White Sands Missile Range. The model MD50C-2 was qualified by General Dynamics Convair for use on the Tomahawk cruise missile.

3.0 TECHNICAL SPECIFICATIONS

The model MD50C-2 is virtually identical to the standard model MD50C-1 except that it employs parts which have a JANTX or B-level rating, is built per WS6536E, and is tested to more stringent requirements.

3.1 **General Characteristics**

3.1.1 Frequency Range: 5.4 to 5.9 GHz

3.1.2 Trigger Sensitivity: -68 dBm minimum for 99 percent reply

3.1.3 Peak Power Output: 50 watts minimum

3.1.4 Standard Reply Delay: 2.0 to 6.0 microseconds

3.1.5 Interrogation Pulse Coding: 3.0 to 12.0 microseconds

3.1.6 Pulse Repetition Frequency Response Range: 2600 pps nominal

3.1.7 Recovery Time: 50 microseconds maximum

3.1.8 Nominal Operating Voltage: 23 to 34 Vdc

3.1.9 Operating Stabilization Time: 3 minutes maximum

3.2 **Receiver/Decoder Characteristics**

3.2.1 Design Type: Superheterodyne

3.2.2 Frequency Range: 5.4 to 5.9 GHz

3.2.3 Receiver Tuning: Mechanical (4 screws)

3.2.4 Frequency Stability: ±3.0 MHz after a 3 minute warmup

3.2.5 3 dB Bandwidth: 11.0 ±3.0 MHz

3.2.6 40 dB Bandwidth: Not specified

3.2.7 Off-Frequency and Image Rejection: 60 dB minimum

3.2.8 Dynamic Signal Range: +10 to -68 dBm

3.2.9 Maximum Input Signal: +10 dBm

3.2.10 Pulse Width Acceptance: 0.25 to 5.0 microseconds in single pulse mode, 0.25 to 1.0 microsecond in the double pulse mode

3.2.11 Pulse Rise Time Acceptance: 0.100 microsecond maximum

3.2.12 Pulse Code Spacing Range: 3.0 to 12.0 microseconds

3.2.13 Decoder Accept Limits: ±0.150 microsecond

3.2.14 Decoder Reject Limits: ±0.300 microsecond

23.2.15 Delay Decision Pulse Trigger Point (Percent of rise time): 50 percent

3.3 **Transmitter Characteristics**

3.3.1 Design Type: Tiode Cavity Oscillator

3.3.2 Frequency Range: 5.4 to 5.9 GHz

3.3.3 Transmitter Tuning: Mechanical (1 screw)

3.3.4 Frequency Stability: ±3.0 MHz plus ±50 KHz/°C maximum

3.3.5 Peak Power Output: 50 watts minimum

3.3.6 Power Spectrum: Bandwidth (MHz) is less than 3.0/pulse width (in microseconds) measured at the 1/4 power level points.

3.3.7 Spectral Purity: First side lobes 7 dB below peak main lobe minimum First nulls 9 dB below peak main lobe minimum.

3.3.8 Spurious Radiation: Not specified

3.3.9 Pulse Repetition Rate Range: 2600 pps nominal

3.3.10 Duty Cycle: Up to 0.002 (0.2 percent)

3.3.11 Pulse Width: 0.5 ±0.1 microsecond

3.3.12 Pulse Width Jitter: 0.01 microsecond maximum

3.3.13 Pulse Amplitude Variation: Not specified

3.3.14 Pulse Rise Time: 0.100 microsecond maximum

3.3.15 Pulse Fall Time: 0.200 microsecond maximum

3.4 **Delay Characteristics**

3.4.1 Absolute System Delay Variation: Not specified

3.4.2 Reply Delay Variations

3.4.2.1 Signal Strength Variation: 0.03 microsecond maximum for input signals between +10 and -60 dBm

3.4.2.2 Interrogation Rate Variation: 0.016 microsecond maximum for prf from 160 to 2600 pps

3.4.2.3 Interrogation Frequency Variation: 0.01 microsecond typical for ±3.0 MHz

3.4.2.4 Pulse Code Spacing Variation: 0.05 microsecond typical for code space variations of ±0.15 microsecond

3.4.2.5 Decision Pulse Rise Time Variation: 0.02 microsecond maximum

3.4.2.6 Input Power Potential Variation: 0.01 microsecond maximum

3.4.2.7 Temperature Variation: 0.01 microsecond maximum from a nominal delay at 80.6°F (27°C) and 0 dBm input for temperatures ranging from -18°F (-28°C) to +156°F (+69°C) and 0.02 microsecond maximum for temperatures ranging from -65.2°F (-54°C) to +185°F (+85°C)

3.4.2.8 Acceleration Variation: Not specified

3.4.3 Reply Delay Jitter: 0.02 microsecond maximum peak to peak for +10 dBm to -55 dBm, and 0.05 microsecond maximum peak to peak for -55 dBm to -60 dBm

3.5 **Radio Frequency Load Matching Characteristics**

3.5.1 Input Impedance: 50 ohm

3.5.2 Output Impedance: 50 ohm

3.5.3 Open-Short Survival: Built in to provide antenna mismatch protection

3.5.4 Voltage Standing Wave Ratio of the Load: 2:1 maximum

3.5.5 Duplexer Type: Four-port circulator

3.6 **Power Supply Characteristics**

3.6.1 Design Type: Series pass regulator with chopper

3.6.2 Input Voltage Range: 23 to 34 Vdc

3.6.3 Under Voltage/Over Voltage Protection: Normal regulation to 20.5 volts input/higher voltage components used

3.6.4 Input Current, Quiescent: 0.250 amp nominal

3.6.5 Input Current, Interrogated at 1000 pps: 0.350 amp nominal

3.6.6 Transient Protection: Provided by regulator portion of power supply

3.6.7 Grounding and Isolation: Power leads isolated from chassis by 1 meg ohm minimum

3.6.8 Standby Operation: None

3.7 **Design Characteristics**

3.7.1 Response to Valid Interrogation: Better than 99 percent for all valid interrogations

3.7.2 Random Triggering and Free Running: Less than 10 pps under all conditions

3.7.3 Transmitter-Receiver Frequency Separation: 50 MHz minimum

3.7.4 Off-Band Rejection Filter: Provided with the three section preselector

3.7.5 Mixer Diode Protection: Limited to +20 dBm input

3.7.6 Power Delay Time: 45 seconds nominal

3.7.7 Reverse Polarity Protection: Provided with series diode

3.7.8 Over-Interrogation Protection: Provided with internal integrator circuit

3.7.9 Lock-Out Protection: Receiver blanked for 50 micro-seconds maximum during transmit time

3.8 **Environmental Specifications**

3.8.1 Operating Temperature: -54°C (-66°F) to +71°C (+160°F)

3.8.2 Nonoperating Temperature: -62.2°C (-80°F) to +75°C (+167°F)

3.8.3 Pressure Altitude: 760 mm of mercury (sea level) to 0.04 mm of mercury (230,000 feet altitude)

3.8.4 Shock: 100g sawtooth for 6 milliseconds duration, operating

3.8.5 Sine Vibration: 5 to 10 Hz, 0.20 inch double amplitude; 10 to 18 Hz, 1g; 18 to 81 Hz, 0.06 inch double amplitude; 81 to 2000 Hz, 20g

3.8.6 Random Vibration: $0.0008g^2$ rms/Hz at 20 Hz, increasing at 6 dB/octave, to $0.20g^2$ rms/Hz at 100 Hz; 16.9g rms from 100 to 1000 Hz; decreasing at 6 dB/octave from $0.20g^2$ rms/Hz at 1000 Hz, to $0.05g^2$ rms/Hz at 2000 Hz. Also lower level vibration for extended duration

3.8.7 Acoustical Noise: Not specified

3.8.8 Random Noise: Not specified

3.8.9 Acceleration: 30g applied along any axis for 1 minute

3.8.10 Humidity: Any, up to 100 percent including condensation because of temperature changes

3.8.11 Salt Fog Atmosphere: Not specified

3.8.12 Rain: Not specified

3.8.13 Sand and Dust: Not specified

3.8.14 Fungus: Not specified

3.8.15 Missile Fuel Compatibility: Not specified

3.8.16 Electromagnetic Interference: Methods CE03, CE06, CS02, CS03, CS04, RE02, RS02, and RS03 of MIL-STD 461

3.9 **Physical/Mechanical Characteristics**

3.9.1 Form: Rectangular

3.9.2 Dimensions, Excluding Protrusions: 4.25L X 3.50W X 2.00H (10.80 X 8.89 X 5.08 cm)

3.9.3 Displacement Volume: 25 cubic inches (405 cubic cm) nominal

3.9.4 Weight: 26 ounces (0.74 kgm) maximum

3.9.5 Pressurization: Sealed at sea level

3.9.6 Mounting Attitude: Any

3.9.7 Mounting Dimensions: 6 holes, 3 in each line spaced 1.050 inches to either side of the center, with the lines separated by 3.200 inches. Clearance holes for #8 screws.

3.9.8 Power and Test Connector Type: MS27476Y08D35P (mates with MS27476Y08D35S)

3.9.9 Radio Frequency Connector Type: SMA female

3.9.10 Type of External Controls: Slotted screwdriver adjust with removal of a seal screw

3.9.11 Pressurization Fitting Type: Schraeder valve mounted on unit

3.9.12 Grounding and Bonding: Entire case at ground potential

3.9.13 Mounting Bracket: None

3.9.14 Mounting Type: Provision for six #8 screws

3.10 **Auxiliary Functions**

3.10.1 External Output Signal Provisions: TM connector providing a pulse concident with the second received uplink pulse

3.10.2 External Input Signal Provisions: None

3.10.3 External Adjustments: Receiver tune, transmitter tune (provided with removal of a seal screw)

3.10.4 External Test Points: None

3.10.5 Internal Test Points: Provided for easy signal tracing

3.11 **Coherent Velocity Specifications**

3.11.1 Pulse Coherence Doppler Error: Not applicable

3.11.2 Dynamic Signal Strength Range: Not applicable

3.11.3 Spectral Skew: Not applicable

3.11.4 Carrier Line Width: Not applicable

3.11.5 Interline Noise: Not applicable

3.11.6 Frequency Locking Range: Not applicable

4.0 **QUALITY/RELIABILITY DATA**

4.1 **Reliability Characteristics**

4.1.1 Design Reliability: The mean time between failures (MTBF) is greater than 30 hours at a 90 percent confidence level

4.1.2 Operational Stability:

4.1.3 Service Life: Not specified

HERLEY INDUSTRIES, INC.
C-BAND RADAR TRACKING TRANSPONDER

Manufacturer's Model Designation:	**MD400C-1**
Manufacturer's Part Number:	**500002-1**
Military Designation:	**None**
Federal Stock Number:	**None**

1.0 GENERAL DESCRIPTION

The model MD400C-1 is a general purpose, precision C-band radar augmentation device with a high sensitivity superheterodyne receiver and magnetron transmitter. Used primarily for range safety functions, the model MD400C is suitable for use in both manned and unmanned vehicles. This transponder is applicable to precision tracking of aircraft, sounding rockets, space-launch vehicles, missiles, and target drones, both sea and airborne. This unit is fully tuneable over the 5.4 to 5.9 GHz range, while being quite small (less than 45 cubic inches) and lightweight (less than 45 ounces), making it suitable for use in applications requiring small size with high power. Environmental requirements are to MIL-STD-810.

2.0 DEVELOPMENT AND UTILIZATION

The model MD400C-1 was developed by Herley Industries, Inc. with company funds to fill the need for a rugged, precision radar transponder, whose modern circuitry greatly improves reliability and performance. The model MD400C-1 is a family of transponders with many minor variations to suit each customer's unique system requirements. Versions of the MD400C-1 have been qualified by White Sands Missile Range (WSMR), New Mexico, NASA Wallops, Virginia, and Naval Air Warfare Center Weapons Division, (NAWCWPNS) Point Mugu, California. It is being used on such programs as NASA's sounding rockets, GBU-15 and AGM-130 at Eglin Air Force Base, Florida, Pegasus and Minuteman Range Systems Launch Program (RSLP) at the 30th Space Wing, Vandenberg Air Force Base, California, range aircraft at numerous facilities, and numerous target and missile applications at WSMR and NAWCWPNS, Point Mugu.

3.0 **TECHNICAL SPECIFICATIONS**

3.1 **General Characteristics**

3.1.1 Frequency Range: 5.4 to 5.9 GHz

3.1.2 Trigger Sensitivity: -70 dBm minimum for 99 percent reply

3.1.3 Peak Power Output: 400 watts minimum

3.1.4 Standard Reply Delay: Adjustable from 1.5 to 6.0 microseconds

3.1.5 Interrogation Pulse Coding: 3.0 to 12.0 microseconds

3.1.6 Pulse Repetition Frequency Response Range: 100 to 4160 pps nominal

3.1.7 Recovery Time: 50 microseconds maximum

3.1.8 Nominal Operating Voltage: 22 to 32 Vdc

3.1.9 Operating Stabilization Time: 3 minutes maximum

3.2 **Receiver/Decoder Characteristics**

3.2.1 Design Type: Superheterodyne

3.2.2 Frequency Range: 5.4 to 5.9 GHz

3.2.3 Receiver Tuning: Mechanical (4 screws)

3.2.4 Frequency Stability: ±3.0 MHz after a 3 minute warmup

3.2.5 3 dB Bandwidth: 11.0 ±3.0 MHz

3.2.6 40 dB Bandwidth: Not specified

3.2.7 Off-Frequency and Image Rejection: 60 dB minimum

3.2.8 Dynamic Signal Range: +20 to -70 dBm

3.2.9 Maximum Input Signal: +20 dBm

3.2.10 Pulse Width Acceptance: 0.25 to 5.0 microseconds in single pulse mode, 0.25 to 1.0 microseconds in the double pulse mode

3.2.11 Pulse Rise Time Acceptance: 0.100 microsecond maximum

3.2.12 Pulse Code Spacing Range: 3.0 to 12.0 microseconds

3.2.13 Decoder Accept Limits: ±0.150 microsecond

3.2.14 Decoder Reject Limits: ±0.300 microsecond

3.2.15 Delay Decision Pulse Trigger Point (Percent of rise time): 50 percent

3.3 **Transmitter Characteristics**

3.3.1 Design Type: Magnetron

3.3.2 Frequency Range: 5.4 to 5.9 GHz

3.3.3 Transmitter Tuning: Mechanical (1 screw)

3.3.4 Frequency Stability: ±2.5 MHz ±50 KHz/°C maximum

3.3.5 Peak Power Output: 400 watts minimum

3.3.6 Power Spectrum: Bandwidth (MHz) is less than 3.0/pulse width (in microseconds) measured at the 1/4 power level points.

3.3.7 Spectral Purity: First side lobes 7 dB below peak main lobe minimum. First nulls 9 dB below peak main lobe minimum.

3.3.8 Spurious Radiation: Not specified

3.3.9 Pulse Repetition Rate Range: 100 to 4160 pps, 2600 pps nominal

3.3.10 Duty Cycle: Up to 0.002 (0.2 percent)

3.3.11 Pulse Width: 0.5 ±0.1 microsecond

3.3.12 Pulse Width Jitter: 0.01 microsecond maximum

3.3.13 Pulse Amplitude Variation: Not specified

3.3.14 Pulse Rise Time: 0.100 microsecond maximum

3.3.15 Pulse Fall Time: 0.200 microsecond maximum

3.4 **Delay Characteristics**

3.4.1 Absolute System Delay Variation: Not specified

3.4.2 Reply Delay Variations

3.4.2.1 Signal Strength Variation: 0.03 microsecond maximum for input signals between 0 and -60 dBm

3.4.2.2 Interrogation Rate Variation: 0.016 microsecond maximum for prf from 160 to 2600 pps

3.4.2.3 Interrogation Frequency Variation: 0.01 microsecond typical for ±3.0 MHz

3.4.2.4 Pulse Code Spacing Variation: 0.05 microsecond typical for code space variations of ±0.15 microsecond

3.4.2.5 Decision Pulse Rise Time Variation: 0.02 microsecond maximum

3.4.2.6 Input Power Potential Variation: 0.01 microsecond maximum

3.4.2.7 Temperature Variation: 0.01 microsecond maximum from a nominal delay at 80.6°F (27°C) and 0 dBm input for temperatures ranging from -18°F (-28°C) to +156°F (+69°C) and 0.02 microsecond maximum for temperatures ranging from -65.2°F (-54°C) to +185°F (+85°C)

3.4.2.8 Acceleration Variation: Not specified

3.4.3 Reply Delay Jitter: 0.02 microsecond maximum peak to peak for 0 dBm to -55 dBm, and 0.05 microsecond maximum peak to peak for -55 dBm to -65 dBm

3.5 **Radio Frequency Load Matching Characteristics**

3.5.1 Input Impedance: 50 ohm

3.5.2 Output Impedance: 50 ohm

3.5.3 Open-Short Survival: Built in to provide antenna mismatch protection

3.5.4 Voltage Standing Wave Ratio of the Load: 2:1 maximum

3.5.5 Duplexer Type: Four-port circulator

3.6 **Power Supply Characteristics**

3.6.1 Design Type: Series pass regulator with chopper

3.6.2 Input Voltage Range: 22 to 32 Vdc

3.6.3 Under Voltage/Over Voltage Protection: Normal regulation to 20.5 volts input/higher voltage components used

3.6.4 Input Current, Quiescent: 0.600 amp nominal

3.6.5 Input Current, Interrogated at 1000 pps: 1.100 amp nominal

3.6.6 Transient Protection: Provided by regulator portion of power supply

3.6.7 Grounding and Isolation: Power leads isolated from chassis by 1 meg ohm minimum

3.6.8 Standby Operation: None

3.7 **Design Characteristics**

3.7.1 esponse to Valid Interrogation: Better than 99 percent for all valid interrogations

3.7.2 Random Triggering and Free Running: Less than 10 pps under all conditions

3.7.3 Transmitter-Receiver Frequency Separation: 50 MHz minimum

3.7.4 Off-Band Rejection Filter: Provided with the three section preselector

3.7.5 Mixer Diode Protection: Limited to +20 dBm input

3.7.6 Power Delay Time: 45 seconds nominal

3.7.7 Reverse Polarity Protection: Provided with series diode

3.7.8 Over-Interrogation Protection: Provided with internal integrator circuit

3.7.9 Lock-Out Protection: Receiver blanked for 50 micro-seconds maximum during transmit time

3.8 **Environmental Specifications**

3.8.1 Operating Temperature: -54°C (-66°F) to +75°C (+167°F)

3.8.2 Nonoperating Temperature: -62.2°C (-80°F) to +75°C (+167°F)

3.8.3 Pressure Altitude: 760 mm of mercury (sea level) to 0.04 mm of mercury (230,000 feet altitude)

3.8.4 Shock: 100g sawtooth for 6 milliseconds duration, operating

3.8.5 Sine Vibration: 5 to 10 Hz, 0.20 inch double amplitude; 10 to 18 Hz, 1g; 18 to 81 Hz, 0.06 inch double amplitude; 81 to 2000 Hz, 20g

3.8.6 Random Vibration: $0.0008g^2$ rms/Hz at 20 Hz, increasing at 6 dB/octave, to $0.20g^2$ rms/Hz at 100 Hz; 16.9g rms from 100 to 1000 Hz; decreasing at 6 dB/octave from $0.20g^2$ rms/Hz at 1000 Hz, to $0.05g^2$ rms/Hz at 2000 Hz

3.8.7 Acoustical Noise: Not specified

3.8.8 Random Noise: Not specified

3.8.9 Acceleration: 30g applied along any axis for 1 minute

3.8.10 Humidity: Any, up to 100 percent including condensation because of temperature changes

3.8.11 Salt Fog Atmosphere: Not specified

3.8.12 Rain: Not specified

3.8.13 Sand and Dust: Not specified

3.8.14 Fungus: Not specified

3.8.15 Missile Fuel Compatibility: Not specified

3.8.16 Electromagnetic Interference: Methods CE03, CS02, CS03, CS04, RE02, RE03, RS02, and RS03 of MIL-STD 461

3.9 **Physical/Mechanical Characteristics**

3.9.1 Form: Rectangular

3.9.2 Dimensions, Excluding Protrusions: 5.00L X 4.68W X 2.53H (12.70 X 11.89 X 6.43 cm)

3.9.3 Displacement Volume: 45 cubic inches (738 cubic cm) nominal

3.9.4 Weight: 45 ounces (1.28 kgm) maximum

3.9.5 Pressurization: Sealed at sea level

3.9.6 Mounting Attitude: Any

3.9.7 Mounting Dimensions: 6 holes, 3 in each line spaced 1.843 inch to either side of the center with the lines separated by 4.687 inches. Clearance holes for #6 screws.

3.9.8 Power and Test Connector Type: MS3114H8-4P (mates with PT06E8-4S or MS3116E8-6S)

3.9.9 Radio Frequency Connector Type: TNC female

3.9.10 Type of External Controls: Slotted screwdriver adjust with removal of a seal screw

3.9.11 Pressurization Fitting Type: Schraeder valve mounted on unit

3.9.12 Grounding and Bonding: Entire case at ground potential

3.9.13 Mounting Bracket: None

3.9.14 Mounting Type: Provision for six #6 screws

3.10 **Auxiliary Functions**

3.10.1 External Output Signal Provisions: TM connector providing a pulse coincident with the second received uplink pulse

3.10.2 External Input Signal Provisions: None

3.10.3 External Adjustments: Receiver tune, transmitter tune (provided with removal of seal screws)

3.10.4 External Test Points: None

3.10.5 Internal Test Points: Provided for easy signal tracing

3.11 **Coherent Velocity Specifications**

3.11.1 Pulse Coherence Doppler Error: Not applicable

3.11.2 Dynamic Signal Strength Range: Not applicable

3.11.3 Spectral Skew: Not applicable

3.11.4 Carrier Line Width: Not applicable

3.11.5 Interline Noise: Not applicable

3.11.6 Frequency Locking Range: Not applicable

4.0 QUALITY/RELIABILITY DATA

4.1 Reliability Characteristics

4.1.1 Design Reliability: The mean time between failures (MTBF) has been tested to greater than 30 hours at a 90 percent confidence level

4.1.2 Operational Stability:

4.1.3 Service Life: Not specified

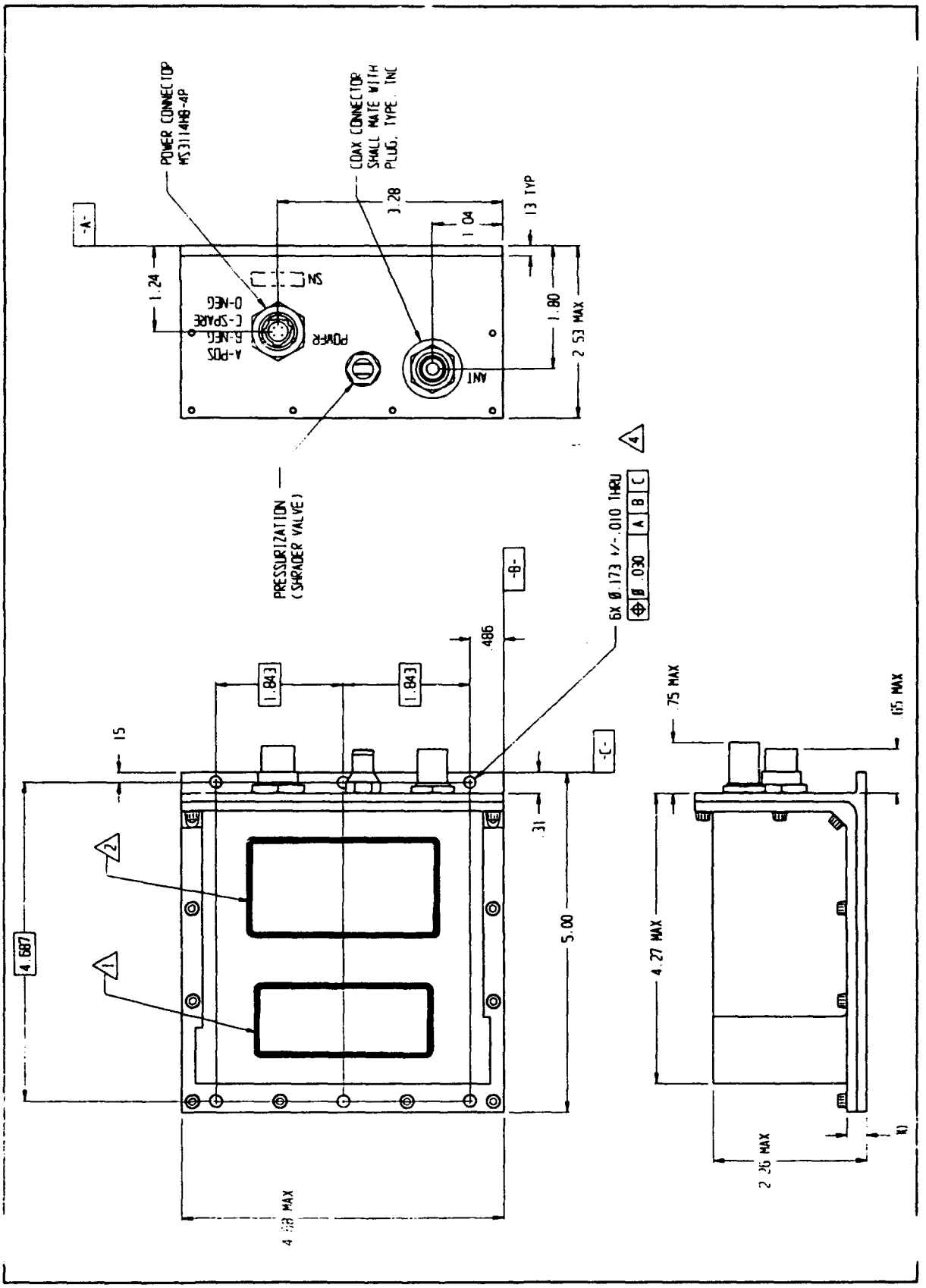

Figure 2-3. MD400C and X all versions, including AN/DPN-90.

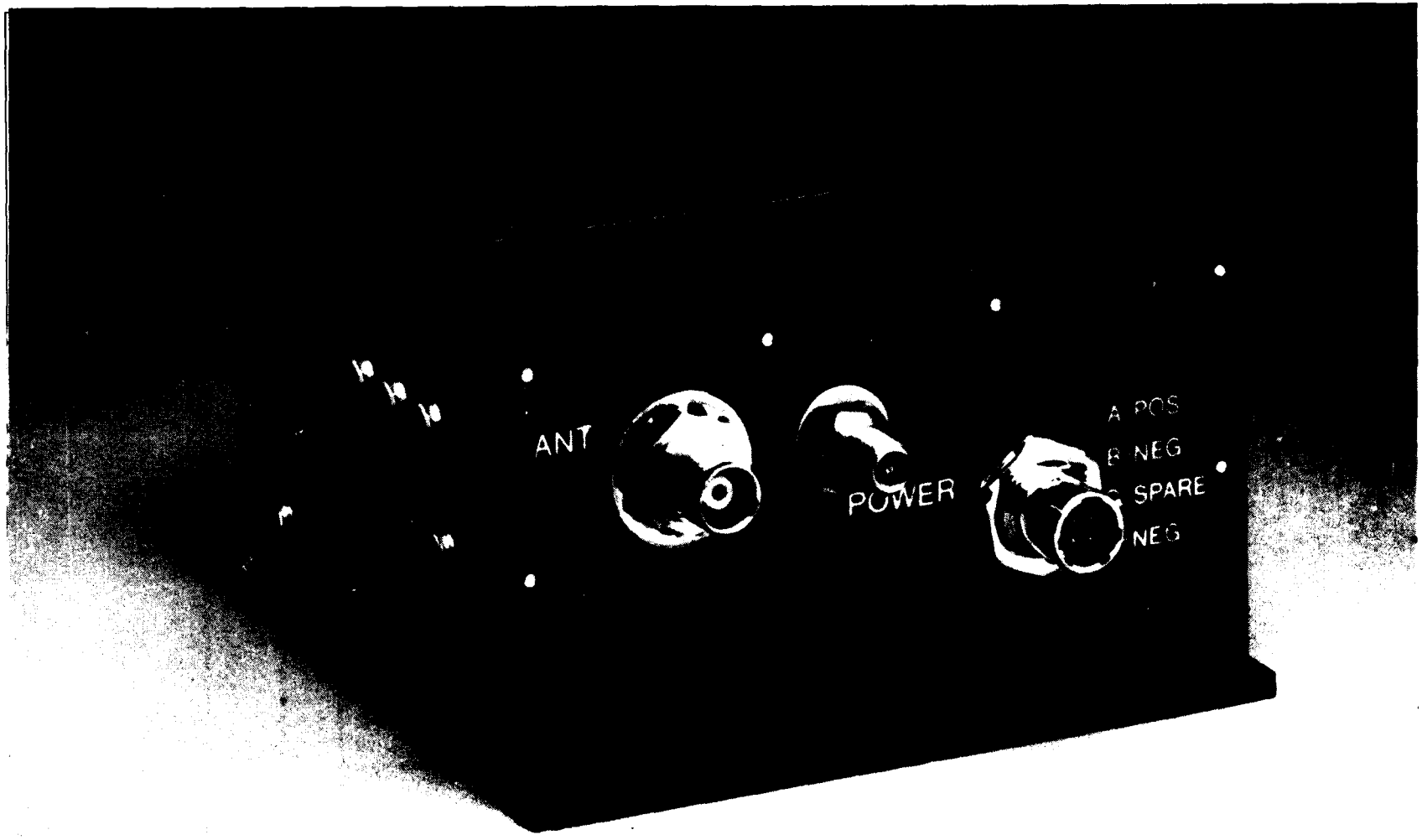

Figure 2-4. Models MD400C and MD400X Transponder Radar (look alike).

HERLEY INDUSTRIES, INC.
C-BAND RADAR TRACKING TRANSPONDER

Manufacturer's Model Designation:	**MD400C-1**
Manufacturer's Part Number:	**500002-3**
Military Designation:	**None**
Federal Stock Number:	**None**

1.0 GENERAL DESCRIPTION

The model MD400C-1 is a general purpose, precision C-band radar augmentation device with a high sensitivity superheterodyne receiver and magnetron transmitter. Used primarily for range safety functions, the model MD400C is suitable for use in both manned and unmanned vehicles. This transponder is applicable to precision tracking of aircraft, sounding rockets, space-launch vehicles, missiles, and target drones, both sea and airborne. This unit is fully tuneable over the 5.4 to 5.9 GHz range, while being quite small (less than 45 cubic inches) and lightweight (less than 45 ounces), making it suitable for use in applications requiring small size with high power. Environmental requirements are to MIL-STD-810.

2.0 DEVELOPMENT AND UTILIZATION

The model MD400C-1 was developed by Herley Industries, Inc. with company funds to fill the need for a rugged, precision radar transponder, whose modern circuitry greatly improves reliability and performance. The model MD400C-1 is a family of transponders with many minor variations to suit each customer's unique system requirements. Versions of the model MD400C-1 have been qualified by White Sands Missile Range (WSMR), New Mexico, NASA Wallops, Virginia, and Naval Air Warfare Center Weapons Division (NAWCWPNS), Point Mugu, California. It is being used on such programs as NASA's sounding rockets, GBU-15 and AGM-130 at Eglin Air Force Base, Florida, Pegasus and Minuteman Range Systems Launch Program (RSLP) at the 30th Space Wing, Vandenberg Air Force Base, California, range aircraft at numerous facilities and numerous target and missile applications at WSMR and NAWCWPNS, Point Mugu.

3.0 TECHNICAL SPECIFICATIONS

The 500002-3 is the same unit as the 500002-1 except that the single pulse/double pulse (SP/DP) receiver selection capability is brought out to the front panel.

HERLEY INDUSTRIES, INC.
C-BAND RADAR TRACKING TRANSPONDER

Manufacturer's Model Designation:	**MD400C-1**
Manufacturer's Part Number:	**500002-4**
Military Designation:	**AN/DPN-90(V)1**
Military Part Number:	**1356AS3020**
Temporary Federal Stock Number:	**LLWY60825**
Permanent Federal Stock Number:	**7RH 1420-01-339-9409**

1.0 GENERAL DESCRIPTION

The model MD400C-1 is a general purpose, precision C-band radar augmentation device with a high sensitivity superheterodyne receiver and magnetron transmitter. Used primarily for range safety functions, the model MD400C is suitable for use in both manned and unmanned vehicles. This transponder is applicable to precision tracking of aircraft, sounding rockets, space-launch vehicles, missiles, and target drones, both sea and airborne. This unit is fully tuneable over the 5.4 to 5.9 GHz range, while being quite small (less than 45 cubic inches) and lightweight (less than 45 ounces), making it suitable for use in applications requiring small size with high power. The model MD400C-1, P/N 500002-4 has been designated by the U.S. Navy as the AN/DPN-90(V)1, P/N 1356AS3020-1. It meets the requirements of specification MIL-T-85678(AS) with regard to performance and environmental conditions.

2.0 DEVELOPMENT AND UTILIZATION

The model MD400C-1 was developed by Herley Industries, Inc. to fill the need for a rugged, precision radar transponder, whose modern circuitry greatly improves reliability and performance. The AN/DPN-90(V)1 version of the model MD400C-1 is a family of transponders with many minor variations to suit each customer's unique system requirements. The AN/DPN-90(V)1 has been qualified in various configurations by the U.S. Navy Naval Air Warfare Center Weapons Division (NAWCWPNS), Point Mugu, California, (formerly Pacific Missile Test Center). It is being used on numerous target and missile applications.

3.0 **TECHNICAL SPECIFICATIONS**

3.1 **General Characteristics**

3.1.1 Frequency Range: 5.4 to 5.9 GHz

3.1.2 Trigger Sensitivity: -70 dBm minimum for 99 percent reply

3.1.3 Peak Power Output: 300 watts minimum (400 watts typical minimum)

3.1.4 Standard Reply Delay: Adjustable from 1.5 to 6.0 microseconds

3.1.5 Interrogation Pulse Coding: 3.0 to 12.0 microseconds

3.1.6 Pulse Repetition Frequency Response Range: 100 to 3000 pps nominal

3.1.7 Recovery Time: 50 microseconds maximum

3.1.8 Nominal Operating Voltage: 21 to 31 Vdc

3.1.9 Operating Stabilization Time: 3 minutes maximum

3.2 **Receiver/Decoder Characteristics**

3.2.1 Design Type: Superheterodyne

3.2.2 Frequency Range: 5.4 to 5.9 GHz

3.2.3 Receiver Tuning: Mechanical (4 screws)

3.2.4 Frequency Stability: ±2.0 MHz after a 3 minute warmup

3.2.5 3 dB Bandwidth: 11.0 ±3.0 MHz

3.2.6 40 dB Bandwidth: Not specified

3.2.7 Off-Frequency and Image Rejection: 60 dB minimum

3.2.8 Dynamic Signal Range: +20 to -70 dBm

3.2.9 Maximum Input Signal: +20 dBm

3.2.10 Pulse Width Acceptance: 0.25 to 1.0 microsecond in single pulse mode, 0.25 to 0.5 microsecond in the double pulse mode

3.2.11 Pulse Rise Time Acceptance: 0.100 microsecond maximum

3.2.12 Pulse Code Spacing Range: 3.0 to 12.0 microseconds

3.2.13 Decoder Accept Limits: ±0.150 microsecond

3.2.14 Decoder Reject Limits: ±0.300 microsecond

3.2.15 Delay Decision Pulse Trigger Point (Percent of rise time): Not specified

3.3 **Transmitter Characteristics**

3.3.1 Design Type: Magnetron

3.3.2 Frequency Range: 5.4 to 5.9 GHz

3.3.3 Transmitter Tuning: Mechanical (1 screw)

3.3.4 Frequency Stability: ±5.0 MHz under all conditions (±3.0 MHz typical)

3.3.5 Peak Power Output: 300 watts minimum (400 watts typical)

3.3.6 Power Spectrum: Not specified

3.3.7 Spectral Purity: Not specified

3.3.8 Spurious Radiation: Not specified

3.3.9 Pulse Repetition Rate Range: 100 to 3000 pps

3.3.10 Duty Cycle: Not specified

3.3.11 Pulse Width: 0.5 ±0.1 microsecond

3.3.12 Pulse Width Jitter: Not specified

3.3.13 Pulse Amplitude Variation: Not specified

3.3.14 Pulse Rise Time: 0.100 microsecond maximum

3.3.15 Pulse Fall Time: 0.200 microsecond maximum

3.4 **Delay Characteristics**

3.4.1 Absolute System Delay Variation: Not specified

3.4.2 Reply Delay Variations

3.4.2.1 Signal Strength Variation: ±0.05 microsecond maximum for input signals between 0 and -63 dBm

3.4.2.2 Interrogation Rate Variation: Not specified

3.4.2.3 Interrogation Frequency Variation: Not specified

3.4.2.4 Pulse Code Spacing Variation: Not specified

3.4.2.5 Decision Pulse Rise Time Variation: Not specified

3.4.2.6 Input Power Potential Variation: Not specified

3.4.2.7 Temperature Variation: Not specified

3.4.2.8 Acceleration Variation: Not specified

3.4.3 Reply Delay Jitter: ±0.02 microsecond maximum for 0 dBm to -55 dBm, and ±0.05 microsecond maximum for -55 dBm to -65 dBm

3.5 **Radio Frequency Load Matching Characteristics**

3.5.1 Input Impedance: 50 ohm

3.5.2 Output Impedance: 50 ohm

3.5.3 Open-Short Survival: Built in to provide antenna mismatch protection

3.5.4 Voltage Standing Wave Ratio of the Load: 2:1 maximum

3.5.5 Duplexer Type: Four-port circulator

3.6 **Power Supply Characteristics**

3.6.1 Design Type: Switching mode regulator with nonsaturating chopper

3.6.2 Input Voltage Range: 21 to 31 Vdc

3.6.3 Under Voltage/Over Voltage Protection: Normal regulation to 20.5 volts input/higher voltage components used

3.6.4 Input Current, Quiescent: 1.0 amp maximum (0.5 amp typical)

3.6.5 Input Current, Interrogated at 1000 pps: 1.1 amp maximum (0.7 amp typical)

3.6.6 Transient Protection: Provided by regulator portion of power supply

3.6.7 Grounding and Isolation: Power leads isolated from chassis by 1 meg ohm minimum

3.6.8 Standby Operation: None

3.7 **Design Characteristics**

3.7.1 Response to Valid Interrogation: Better than 99 percent for all valid interrogations

3.7.2 Random Triggering and Free Running: Less than 10 ppm under all conditions

3.7.3 Transmitter-Receiver Frequency Separation: 50 MHz minimum

3.7.4 Off-Band Rejection Filter: Provided with the three section preselector

3.7.5 Mixer Diode Protection: Limited to +20 dBm input

3.7.6 Power Delay Time: 45 seconds nominal

3.7.7 Reverse Polarity Protection: Provided with series diode

3.7.8 Over-Interrogation Protection: Provided with internal integrator circuit

3.7.9 Lock-Out Protection: Receiver blanked for 50 microseconds maximum during transmit time

3.8 **Environmental Specifications**

3.8.1 Operating Temperature: -54°C (-66°F) to +71°C (+160°F)

3.8.2 Nonoperating Temperature: -62.2°C (-80°F) to +95°C (+203°F)

3.8.3 Pressure Altitude: 760 mm of mercury (sea level) to 8.00 mm of mercury (100,000 feet altitude)

3.8.4 Shock: 100g sawtooth for 11 milliseconds duration, operating

3.8.5 Sine Vibration: 5 to 14 Hz, 0.10 inch double amplitude; 14 to 23 Hz, 1g; 23 to 74 Hz, 0.036 inch double amplitude; 74 to 2000 Hz, 10g, unit operating

3.8.6 Random Vibration: Not specified

3.8.7 Acoustical Noise: Not specified

3.8.8 Random Noise: Not specified

3.8.9 Acceleration: Not specified

3.8.10 Humidity: Up to 95 percent at 65°C for 6 hours for 3 cycles

3.8.11 Salt Fog Atmosphere: Not specified

3.8.12 Rain: Not specified

3.8.13 Sand and Dust: Not specified

3.8.14 Fungus: Not specified

3.8.15 Missile Fuel Compatibility: Not specified

3.8.16 Electromagnetic Interference: Methods CE03, CE07, CS01, CS02, CS06, RE02, RE03, RS02, and RS03 of MIL-STD 461

3.9 **Physical/Mechanical Characteristics**

3.9.1 Form: Rectangular

3.9.2 Dimensions, Excluding Protrusions: 5.00L X 4.68W X 2.53H (12.70 X 11.89 X 6.43 cm)

3.9.3 Displacement Volume: 45 cubic inches (738 cubic cm) nominal

3.9.4 Weight: 45 ounces (1.28 kgm) maximum

3.9.5 Pressurization: Sealed at sea level

3.9.6 Mounting Attitude: Any

3.9.7 Mounting Dimensions: 6 holes, 3 in each line spaced 1.843 inch to either side of the center with the lines separated by 4.687 inches. Clearance holes for #6 screws.

3.9.8 Power and Test Connector Type: MS3114H8-4P (mates with PT06E8-4S or MS3116E8-6S)

3.9.9 Radio Frequency Connector Type: TNC female

3.9.10 Type of External Controls: Slotted screwdriver adjust with removal of a seal screw

3.9.11 Pressurization Fitting Type: Schraeder valve mounted on unit

3.9.12 Grounding and Bonding: Entire case at ground potential

3.9.13 Mounting Bracket: None

3.9.14 Mounting Type: Provision for six #6 screws

3.10 **Auxiliary Functions**

3.10.1 External Output Signal Provisions: None

3.10.2 External Input Signal Provisions: None

3.10.3 External Adjustments: Receiver tune, transmitter tune (provided with removal of seal screws)

3.10.4 External Test Points: None

3.10.5 Internal Test Points: Provided for easy signal tracing

3.11 **Coherent Velocity Specifications**

3.11.1 Pulse Coherence Doppler Error: Not applicable

3.11.2 Dynamic Signal Strength Range: Not applicable

3.11.3 Spectral Skew: Not applicable

3.11.4 Carrier Line Width: Not applicable

3.11.5 Interline Noise: Not applicable

3.11.6 Frequency Locking Range: Not applicable

4.0 **QUALITY/RELIABILITY DATA**

4.1 **Reliability Characteristics**

4.1.1 Design Reliability: The mean time between failures (MTBF) has been tested to greater than 50 hours at a 90 percent confidence level

4.1.2 Operational Stability: Not specified

4.1.3 Service Life: Not specified

HERLEY INDUSTRIES, INC.
C-BAND RADAR TRACKING TRANSPONDER

Manufacturer's Model Designation:	**MD400C-1**
Manufacturer's Part Number:	**500002-6**
Military Designation:	**None**
Federal Stock Number:	**None**

1.0 GENERAL DESCRIPTION

The model MD400C-1 is a general purpose, precision C-band radar augmentation device with a high sensitivity superheterodyne receiver and magnetron transmitter. Used primarily for range safety functions, the model MD400C is suitable for use in both manned and unmanned vehicles. This transponder is applicable to precision tracking of aircraft, sounding rockets, space-launch vehicles, missiles, and target drones, both sea and airborne. This unit is fully tuneable over the 5.4 to 5.9 GHz range, while being quite small (less than 45 cubic inches) and lightweight (less than 45 ounces), making it suitable for use in applications requiring small size with high power. Environmental requirements are to MIL-STD-810.

2.0 DEVELOPMENT AND UTILIZATION

The model MD400C-1 was developed by Herley Industries, Inc. with company funds to fill the need for a rugged, precision radar transponder, whose modern circuitry greatly improves reliability and performance. The model MD400C-1 is a family of transponders with many minor variations to suit each customer's unique system requirements. Versions of the model MD400C-1 have been qualified by White Sands Missile Range (WSMR), New Mexico, NASA Wallops, Virginia, and Naval Air Warfare Center Weapons Division (NAWCWPNS), Point Mugu, California. It is being used on such programs as NASA's sounding rockets, GBU-15 and AGM-130 at Eglin Air Force Base, Florida, Pegasus and Minuteman Range Systems Launch Program (RSLP) at the 30th Space Wing, Vandenberg Air Force Base, California, range aircraft at numerous facilities and numerous target and missile applications at WSMR and NAWCWPNS, Point Mugu.

3.0 TECHNICAL SPECIFICATIONS

The 500002-6 is the same unit as the 500002-1 except that a band-limiting filter has been incorporated to meet the requirements for flight at the 30th Space Wing.

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HERLEY INDUSTRIES, INC.
C-BAND RADAR TRACKING TRANSPONDER

Manufacturer's Model Designation:	**MD400C-1**
Manufacturer's Part Number:	**500002-7**
Military Designation:	**None**
Federal Stock Number:	**None**

1.0 GENERAL DESCRIPTION

The model MD400C-1 is a general purpose, precision C-band radar augmentation device with a high sensitivity superheterodyne receiver and magnetron transmitter. Used primarily for range safety functions, the model MD400C is suitable for use in both manned and unmanned vehicles. This transponder is applicable to precision tracking of aircraft, sounding rockets, space-launch vehicles, missiles, and target drones, both sea and airborne. This unit is fully tuneable over the 5.4 to 5.9 GHz range, while being quite small (less than 45 cubic inches) and lightweight (less than 45 ounces), making it suitable for use in applications requiring small size with high power.

2.0 DEVELOPMENT AND UTILIZATION

The model MD400C-1 was developed by Herley Industries, Inc. with company funds to fill the need for a rugged, precision radar transponder, whose modern circuitry greatly improves reliability and performance. The model MD400C-1 is a family of transponders with many minor variations to suit each customer's unique system requirements. Versions of the model MD400C-1 have been qualified by White Sands Missile Range (WSMR), New Mexico, NASA Wallops, Virginia, and Naval Air Warfare Center Weapons Division (NAWCWPNS), Point Mugu, California. It is being used on such programs as NASA's sounding rockets, GBU-15 and AGM-130 at Eglin Air Force Base, Florida, Pegasus and Minuteman Range Systems Launch Program (RSLP) at the 30th Space Wing, Vandenberg Air Force Base, California, range aircraft at numerous facilities and numerous target and missile applications at WSMR and NAWCWPNS, Point Mugu.

3.0 TECHNICAL SPECIFICATIONS

The model MD400C-1, P/N 500002-7 is the same as the standard Herley MD400C-1, P/N 500002-1 except that some improvements were made in the configuration to enhance EMI performance. Additionally, the customer specification requires that the telemetry in and out connectors on the front panel be SMA rather than the TM variety used on the standard unit. This configuration is used at White Sands Missile Range (WSMR), New Mexico, on a variety of missile test programs.

3.1 General Characteristics

3.1.1 Frequency Range: 5.4 to 5.9 GHz

3.1.2 Trigger Sensitivity: -68 dBm minimum for 99 percent reply

3.1.3 Peak Power Output: 200 watts minimum (400 watts typical)

3.1.4 Standard Reply Delay: Adjustable from 1.5 to 6.0 microseconds

3.1.5 Interrogation Pulse Coding: 3.0 to 12.0 microseconds

3.1.6 Pulse Repetition Frequency Response Range: 100 to 2600 pps nominal

3.1.7 Recovery Time: 50 microseconds maximum

3.1.8 Nominal Operating Voltage: 22 to 32 Vdc

3.1.9 Operating Stabilization Time: 3 minutes maximum

3.2 Receiver/Decoder Characteristics

3.2.1 Design Type: Superheterodyne

3.2.2 Frequency Range: 5.4 to 5.9 GHz

3.2.3 Receiver Tuning: Mechanical (4 screws)

3.2.4 Frequency Stability: ±2.0 MHz after a 3 minute warmup

3.2.5 3 dB Bandwidth: 11.0 ±5.0 MHz

3.2.6 40 dB Bandwidth: Not specified

3.2.7 Off-Frequency and Image Rejection: 60 dB minimum

3.2.8 Dynamic Signal Range: +20 to -68 dBm

3.2.9 Maximum Input Signal: +20 dBm

3.2.10 Pulse Width Acceptance: 0.25 to 1.0 microsecond in single pulse mode, 0.25 to 1.0 microsecond in the double pulse mode

3.2.11 Pulse Rise Time Acceptance: 0.100 microsecond maximum

3.2.12 Pulse Code Spacing Range: 3.0 to 12.0 microseconds

3.2.13 Decoder Accept Limits: ±0.150 microsecond

3.2.14 Decoder Reject Limits: ±0.300 microsecond

3.2.15 Delay Decision Pulse Trigger Point (Percent of rise time): 50 percent

3.3 **Transmitter Characteristics**

3.3.1 Design Type: Magnetron

3.3.2 Frequency Range: 5.4 to 5.9 GHz

3.3.3 Transmitter Tuning: Mechanical (1 screw)

3.3.4 Frequency Stability: ±3.0 MHz under all operating conditions

3.3.5 Peak Power Output: 200 watts minimum (400 watts typical)

3.3.6 Power Spectrum: Bandwidth (MHz) is less than 3.0/pulse width (in microseconds) measured at the 1/4 power level points.

3.3.7 Spectral Purity: First side lobes 7 dB below peak main lobe minimum. First nulls 9 dB below peak main lobe minimum.

3.3.8 Spurious Radiation: Not specified

3.3.9 Pulse Repetition Rate Range: 100 to 2600 pps

3.3.10 Duty Cycle: Not specified

3.3.11 Pulse Width: Adjustable from 0.47 to 0.53 microsecond

3.3.12 Pulse Width Jitter: 0.01 microsecond peak to peak maximum

3.3.13 Pulse Amplitude Variation: Not specified

3.3.14 Pulse Rise Time: 0.100 microsecond maximum

3.3.15 Pulse Fall Time: 0.200 microsecond maximum

3.4 **Delay Characteristics**

3.4.1 Absolute System Delay Variation: ±0.1 microsecond at 0 dBm

3.4.2 Reply Delay Variations

3.4.2.1 Signal Strength Variation: 0.03 microsecond maximum for input signals between +10 and -60 dBm

3.4.2.2 Interrogation Rate Variation: 0.016 microsecond maximum for prf from 160 to 2400 pps

3.4.2.3 Interrogation Frequency Variation: 0.01 microsecond typical for ±3.0 MHz

3.4.2.4 Pulse Code Spacing Variation: 0.05 microsecond typical for code space variations of ±0.15 microsecond

3.4.2.5 Decision Pulse Rise Time Variation: Not specified

3.4.2.6 Input Power Potential Variation: 0.01 microsecond maximum from 22 to 32 Vdc

3.4.2.7 Temperature Variation: 0.01 microsecond maximum from a nominal delay at 80.6°F (27°C) and 0 dBm input for temperatures ranging from -18°F (-28°C) to +156°F (+69°C) and 0.02 microsecond maximum for temperatures ranging from -65.2°F (-54°C) to +185°F (+85°C)

3.4.2.8 Acceleration Variation: Not specified

3.4.3 Reply Delay Jitter: 0.02 microsecond maximum peak to peak for 0 dBm to -55 dBm, and 0.05 microsecond maximum peak to peak for -55 dBm to -65 dBm

3.5 **Radio Frequency Load Matching Characteristics**

3.5.1 Input Impedance: 50 ohm

3.5.2 Output Impedance: 50 ohm

3.5.3 Open-Short Survival: Built in to provide antenna mismatch protection

3.5.4 Voltage Standing Wave Ratio of the Load: 2:1 maximum

3.5.5 Duplexer Type: Four-port circulator

3.6 **Power Supply Characteristics**

3.6.1 Design Type: Switching mode regulator with nonsaturating chopper

3.6.2 Input Voltage Range: 22 to 32 Vdc

3.6.3 Under Voltage/Over Voltage Protection: Normal regulation to 20.5 volts input/higher voltage components used

3.6.4 Input Current, Quiescent: 0.6 amp maximum (0.5 amp typical)

3.6.5 Input Current, Interrogated at 1000 pps: 1.100 amp maximum (0.7 amp typical)

3.6.6 Transient Protection: Provided by regulator portion of power supply

3.6.7 Grounding and Isolation: Power leads isolated from chassis by 1 meg ohm minimum

3.6.8 Standby Operation: None

3.7 **Design Characteristics**

3.7.1 Response to Valid Interrogation: Better than 99 percent for all valid interrogations

3.7.2 Random Triggering and Free Running: Less than 10 pps under all conditions

3.7.3 Transmitter-Receiver Frequency Separation: 50 MHz minimum

3.7.4 Off-Band Rejection Filter: Provided with the three section preselector

3.7.5 Mixer Diode Protection: Limited to +20 dBm input

3.7.6 Power Delay Time: 45 seconds nominal

3.7.7 Reverse Polarity Protection: Provided with series diode

3.7.8 Over-Interrogation Protection: Provided with internal integrator circuit

3.7.9 Lock-Out Protection: Receiver blanked for 50 microseconds maximum during transmit time

3.8 **Environmental Specifications**

3.8.1 Operating Temperature: -37°C (-34°F) to +88°C (+190°F)

3.8.2 Nonoperating Temperature: -54°C (-66°F) to +75°C (+167°F)

3.8.3 Pressure Altitude: 760 mm of mercury (sea level) to 33 mm of mercury (70,000 feet altitude).

3.8.4 Shock: 100g sawtooth for 6 milliseconds duration, operating

3.8.5 Sine Vibration: 5 to 10 Hz, 0.20 inch double amplitude; 10 to 18 Hz, 1g; 18 to 81 Hz, 0.06 inch double amplitude; 81 to 2000 Hz, 20g

3.8.6 Random Vibration: $0.0008g^2$ rms/Hz at 20 Hz, increasing at 6 dB/octave, to $0.20g^2$ rms/Hz at 100 Hz; 16.9g rms from 100 to 1000 Hz; decreasing at 6 dB/octave from $0.20g^2$ rms/Hz at 1000 Hz, to $0.05g^2$ rms/Hz at 2000 Hz

3.8.7 Acoustical Noise: Not specified

3.8.8 Random Noise: Not specified

3.8.9 Acceleration: 30g applied along any axis for 1 minute

3.8.10 Humidity: Any, up to 100 percent including condensation because of temperature changes

3.8.11 Salt Fog Atmosphere: Not specified

3.8.12 Rain: Not specified

3.8.13 Sand and Dust: Not specified

3.8.14 Fungus: Not specified

3.8.15 Missile Fuel Compatibility: Not specified

3.8.16 Electromagnetic Interference: Methods CE03, CE06, CS02, CS03, CS04, RE02, RS02, and RS03 of MIL-STD 461

3.9 **Physical/Mechanical Characteristics**

3.9.1 Form: Rectangular

3.9.2 Dimensions, Excluding Protrusions: 5.00L X 4.68W X 2.53H (12.7 X 11.89 X 6.43 cm)

3.9.3 Displacement Volume: 45 cubic inches (738 cubic cm) nominal

3.9.4 Weight: 45 ounces (1.28 kgm) maximum

3.9.5 Pressurization: Sealed at sea level

3.9.6 Mounting Attitude: Any

3.9.7 Mounting Dimensions: 6 holes, 3 in each line spaced 1.843 inch to either side of the center, with the lines separated by 4.687 inches. Clearance holes for #6 screws.

3.9.8 Power and Test Connector Type: MS3114H8-4P (mates with PT06E8-4S or MS3116E8-6S)

3.9.9 Radio Frequency Connector Type: TNC female

3.9.10 Type of External Controls: Slotted screwdriver adjust with removal of a seal screw

3.9.11 Pressurization Fitting Type: Schraeder valve mounted on unit

3.9.12 Grounding and Bonding: Entire case at ground potential

3.9.13 Mounting Bracket: None

3.9.14 Mounting Type: Provision for six #6 screws

3.10 **Auxiliary Functions**

3.10.1 External Output Signal Provisions: SMA connector for TM output pulses.

3.10.2 External Input Signal Provisions: SMA connector for TM input pulses

3.10.3 External Adjustments: Receiver tune, transmitter tune (provided with removal of seal screws)

3.10.4 External Test Points: In the power connector; pin C - video pulse, pin D - gate pulse

3.10.5 Internal Test Points: Provided for easy signal tracing

3.11 **Coherent Velocity Specifications**

3.11.1 Pulse Coherence Doppler Error: Not applicable

3.11.2 Dynamic Signal Strength Range: Not applicable

3.11.3 Spectral Skew: Not applicable

3.11.4 Carrier Line Width: Not applicable

3.11.5 Interline Noise: Not applicable

3.11.6 Frequency Locking Range: Not applicable

4.0 **QUALITY/RELIABILITY DATA**

4.1 **Reliability Characteristics**

4.1.1 Design Reliability: The mean time between failures (MTBF) has been tested to greater than 30 hours at a 90 percent confidence level

4.1.2 Operational Stability: Not specified

4.1.3 Service Life: Not specified

HERLEY INDUSTRIES, INC.
C-BAND RADAR TRACKING TRANSPONDER

Manufacturer's Model Designation: **MD400C-1**
Manufacturer's Part Number: **500002-8**
Military Designation:
Federal Stock Number:

1.0 GENERAL DESCRIPTION

The model MD400C-1 is a general purpose, precision C-band radar augmentation device with a high sensitivity superheterodyne receiver and magnetron transmitter. Used primarily for range safety functions, the model MD400C is suitable for use in both manned and unmanned vehicles. This transponder is applicable to precision tracking of aircraft, sounding rockets, space-launch vehicles, missiles, and target drones, both sea and airborne. This unit is fully tuneable over the 5.4 to 5.9 GHz range, while being quite small (less than 45 cubic inches) and lightweight (less than 45 ounces), making it suitable for use in applications requiring small size with high power.

2.0 DEVELOPMENT AND UTILIZATION

The model MD400C-1 was developed by Herley Industries, Inc. with company funds to fill the need for a rugged, precision radar transponder, whose modern circuitry greatly improves reliability and performance. The model MD400C-1 is a family of transponders with many minor variations to suit each customer's unique system requirements. Versions of the model MD400C-1 have been qualified by White Sands Missile Range (WSMR), New Mexico, NASA Wallops, Virginia, and Naval Air Test Center Weapons Division (NAWCWPNS), Point Mugu, California. It is being used on such programs as NASA's sounding rockets, GBU-15 and AGM-130 at Eglin Air Force Base, Florida, Pegasus and Minuteman Range Systems Launch Program (RSLP) at the 30th Space Wing, Vandenberg Air Force Base, California, range aircraft at numerous facilities and numerous target and missile applications at WSMR and NAWCWPNS, Point Mugu.

3.0 TECHNICAL SPECIFICATIONS

The model MD400C-1, P/N 500002-8 is the same configuration and meets the same specification as the Herley MD400C-1, P/N 500002-7. The 500002-8 differs in that the customer specification requires special interfaces for the telemetry in and out connectors on the front panel. This configuration is used at White Sands Missile Range (WSMR) on a variety of missile test programs.

HERLEY INDUSTRIES, INC.
C-BAND RADAR TRACKING TRANSPONDER

Manufacturer's Model Designation:	**MD400C-1**
Manufacturer's Part Number:	**500002-10**
Military Designation:	**None**
Federal Stock Number:	**None**
OSC Part Number:	**1000-6005-03**

1.0 GENERAL DESCRIPTION

The model MD400C-1 is a general purpose, precision C-band radar augmentation device with a high sensitivity superheterodyne receiver and magnetron transmitter. Used primarily for range safety functions, the model MD400C is suitable for use in both manned and unmanned vehicles. This transponder is applicable to precision tracking of aircraft, sounding rockets, space-launch vehicles, missiles, and target drones, both sea and airborne. This unit is fully tuneable over the 5.4 to 5.9 GHz range, while being quite small (less than 45 cubic inches) and lightweight (less than 45 ounces), making it suitable for use in applications requiring small size with high power.

2.0 DEVELOPMENT AND UTILIZATION

The model MD400C-1 was developed by Herley Industries, Inc. with company funds to fill the need for a rugged, precision radar transponder, whose modern circuitry greatly improves reliability and performance. The model MD400C-1 is a family of transponders with many minor variations to suit each customer's unique system requirements. Versions of the model MD400C-1 have been qualified by White Sands Missile Range (WSMR), New Mexico, NASA Wallops, Virginia, and Naval Air Warfare Center Weapons Division (NAWCWPNS), Point Mugu, California. It is being used on such programs as NASA's sounding rockets, GBU-15 and AGM-130 at Eglin Air Force Base, Florida. The 50002-10 has been qualified by Orbital Sciences and the United States Air Force for use at the 30th Space Wing, Vandenberg Air Force Base, California. Program applications include Pegasus, LEAP, Consolidated Front End (CFE), Taurus, and Minuteman Range Systems Launch Program (RSLP).

3.0 TECHNICAL SPECIFICATIONS

The 500002-10 version of the Herley model MD400C-1 is part of that overall transponder family. This version meets the specifications of the 500002-1, and in addition, since it is based on the configuration of the improved U.S. Navy DPN-90 version, has all of the improvements of the 500002-4 built in. These improvements include the higher efficiency power supply which results in lower current and higher reliability from both reduced parts count and improved circuitry. In addition, the 500002-10 incorporates a bandwidth limiting filter to meet the requirements of the 30th Space Wing. Telemetry IN and OUT connectors on the front panel are an optional feature.

3.1 General Characteristics

3.1.1 Frequency Range: 5.4 to 5.9 GHz

3.1.2 Trigger Sensitivity: -70 dBm minimum for 99 percent reply

3.1.3 Peak Power Output: 400 watts minimum

3.1.4 Standard Reply Delay: Adjustable from 1.5 to 6.0 microseconds

3.1.5 Interrogation Pulse Coding: 3.0 to 12.0 microseconds

3.1.6 Pulse Repetition Frequency Response Range: 100 to 3000 pps nominal

3.1.7 Recovery Time: 50 microseconds maximum

3.1.8 Nominal Operating Voltage: 24 to 32 Vdc

3.1.9 Operating Stabilization Time: 5 minutes maximum

3.2 Receiver/Decoder Characteristics

3.2.1 Design Type: Superheterodyne

3.2.2 Frequency Range: 5.4 to 5.9 GHz

3.2.3 Receiver Tuning: Mechanical (4 screws)

3.2.4 Frequency Stability: ±3.. MHz after a 3 minute warmup

3.2.5 3 dB Bandwidth: 11.0 ±3.0 MHz

3.2.6 40 dB Bandwidth: Not specified

3.2.7 Off-Frequency and Image Rejection: 60 dB minimum

3.2.8 Dynamic Signal Range: 0 to -65 dBm

3.2.9 Maximum Input Signal: 0 dBm

3.2.10 Pulse Width Acceptance: 0.25 to 1.0 microsecond in single pulse mode, 0.25 to 0.5 microsecond in the double pulse mode

3.2.11 Pulse Rise Time Acceptance: 0.200 microsecond or less

3.2.12 Pulse Code Spacing Range: 3.0 to 12.0 microseconds

3.2.13 Decoder Accept Limits: ±0.150 microsecond

3.2.14 Decoder Reject Limits: ±0.300 microsecond

3.2.15 Delay Decision Pulse Trigger Point (Percent of rise time): 50 percent

3.3 **Transmitter Characteristics**

3.3.1 Design Type: Magnetron

3.3.2 Frequency Range: 5.4 to 5.9 GHz

3.3.3 Transmitter Tuning: Mechanical (1 screw)

3.3.4 Frequency Stability: ±3.0 MHz plus ±50 KHz/°C maximum

3.3.5 Peak Power Output: 400 watts minimum

3.3.6 Power Spectrum: Bandwidth (MHz) is less than 3.0/pulse width (in microseconds) measured at the 1/4 power level points.

3.3.7 Spectral Purity: Not specified

3.3.8 Spurious Radiation: Not specified

3.3.9 Pulse Repetition Rate Range: 100 to 3000 pps

3.3.10 Duty Cycle: Up to 0.002 (0.2 percent)

3.3.11 Pulse Width: 0.5 ±0.1 microsecond

3.3.12 Pulse Width Jitter: 0.01 microsecond maximum

3.3.13 Pulse Amplitude Variation: Not specified

3.3.14 Pulse Rise Time: 0.100 microsecond maximum

3.3.15 Pulse Fall Time: 0.200 microsecond maximum

3.4 **Delay Characteristics**

3.4.1 Absolute System Delay Variation: Not specified

3.4.2 Reply Delay Variations

3.4.2.1 Signal Strength Variation: ±0.03 microsecond maximum for input signals between 0 and -65 dBm

3.4.2.2 Interrogation Rate Variation: Not specified

3.4.2.3 Interrogation Frequency Variation: Not specified

3.4.2.4 Pulse Code Spacing Variation: Not specified

3.4.2.5 Decision Pulse Rise Time Variation: Not specified

3.4.2.6 Input Power Potential Variation: Not specified

3.4.2.7 Temperature Variation: Not specified

3.4.2.8 Acceleration Variation: Not specified

3.4.3 Reply Delay Jitter: 0.02 microsecond maximum peak to peak for 0 dBm to -55 dBm, and 0.05 microsecond maximum peak to peak for -55 dBm to -65 dBm

3.5 **Radio Frequency Load Matching Characteristics**

3.5.1 Input Impedance: 50 ohm

3.5.2 Output Impedance: 50 ohm

3.5.3 Open-Short Survival: Built in to provide antenna mismatch protection

3.5.4 Voltage Standing Wave Ratio of the Load: 2:1 maximum

3.5.5 Duplexer Type: Four-port circulator

3.6 **Power Supply Characteristics**

3.6.1 Design Type: Switching mode regulator with non-saturating chopper

3.6.2 Input Voltage Range: 24 to 32 Vdc

3.6.3 Under Voltage/Over Voltage Protection: Normal regulation to 20.5 volts input/higher voltage components used

3.6.4 Input Current, Quiescent: 0.50 amp maximum

3.6.5 Input Current, Interrogated at 1000 pps: 0.70 amp maximum

3.6.6 Transient Protection: Provided by regulator portion of power supply

3.6.7 Grounding and Isolation: Power leads isolated from chassis by 1 meg ohm minimum

3.6.8 Standby Operation: None

3.7 **Design Characteristics**

3.7.1 Response to Valid Interrogation: Better than 99 percent for all valid interrogations

3.7.2 Random Triggering and Free Running: Less than 10 pps under all conditions

3.7.3 Transmitter-Receiver Frequency Separation: 50 MHz minimum

3.7.4 Off-Band Rejection Filter: Provided with the three section preselector

3.7.5 Mixer Diode Protection: Limited to +20 dBm input

3.7.6 Power Delay Time: 45 seconds nominal

3.7.7 Reverse Polarity Protection: Provided with series diode

3.7.8 Over-Interrogation Protection: Provided with internal integrator circuit

3.7.9 Lock-Out Protection: Receiver blanked for 50 micro-seconds maximum during transmit time

3.8 **Environmental Specifications**

3.8.1 Operating Temperature: -37°C (-35°F) to +71°C (+160°F) for 24 temperature cycles

3.8.2 Nonoperating Temperature: -62.2°C (-80°F) to +75°C (+167°F)

3.8.3 Pressure Altitude: 760 mm of mercury (sea level) to 0.04 mm of mercury (230,000 feet altitude)

3.8.4 Shock: Pyro shock spectrum from 10 to 2000 Hz, 1556g at 430 Hz, increasing to 2000g at 2000 Hz

3.8.5 Sine Vibration: 5 to 2000 Hz, 20g level 60 to 2000 Hz

3.8.6 Random Vibration: $0.03g^2$ rms/Hz at 20 Hz, increasing at 9 dB/octave to 35/Hz, 35 to 2000 Hz at $0.16g^2$ rms/Hz. Overall = 17.8g rms

3.8.7 Acoustical Noise: Not specified

3.8.8 Random Noise: Not specified

3.8.9 Acceleration: Longitudal ±30g, Lateral ±3g

3.8.10 Humidity: From 0 to 100 percent including condensation because of to temperature changes

3.8.11 Salt Fog Atmosphere: Per MIL-STD-810C, Method 509.1

3.8.12 Rain: 4 inches per hour for 2 hours

3.8.13 Sand and Dust: Per MIL-STD-810C, Method 510.1

3.8.14 Fungus: Per MIL-STD-454, Requirement 4

3.8.15 Missile Fuel Compatibility: Per MIL-STD-810C, Method 511.1

3.8.16 Electromagnetic Interference: Methods CE03, CE06, CE07, CS01, CS02, CS06, RE02, and RS03 of MIL-STD 461

3.9 **Physical/Mechanical Characteristics**

3.9.1 Form: Rectangular

3.9.2 Dimensions, Excluding Protrusions: 5.00L X 4.68W X 2.53H (12.70 X 11.89 X 6.43 cm)

3.9.3 Displacement Volume: 45 cubic inches (738 cubic cm) nominal

3.9.4 Weight: 45 ounces (1.28 kgm) maximum

3.9.5 Pressurization: Sealed at sea level

3.9.6 Mounting Attitude: Any

3.9.7 Mounting Dimensions: 6 holes, 3 in each line spaced 1.843 inch to either side of the center, with the lines separated by 4.687 inches. Clearance holes for #6 screws.

3.9.8 Power and Test Connector Type: MS3114H8-4P (mates with PT06E8-4S or MS3116E8-6S)

3.9.9 Radio Frequency Connector Type: TNC female

3.9.10 Type of External Controls: Slotted screwdriver adjust with removal of a seal screw

3.9.11 Pressurization Fitting Type: Schraeder valve mounted on unit

3.9.12 Grounding and Bonding: Entire case at ground potential

3.9.13 Mounting Bracket: None

3.9.14 Mounting Type: Provision for six #6 screws

3.10 **Auxiliary Functions**

3.10.1 External Output Signal Provisions: None

3.10.2 External Input Signal Provisions: None

3.10.3 External Adjustments: Receiver tune, transmitter tune and code spacing (provided with removal of seal screws)

3.10.4 External Test Points: Test points in power connector; pin C - video pulse, pin D - gate pulse

3.10.5 Internal Test Points: Provided for easy signal tracing

3.11 **Coherent Velocity Specifications**

3.11.1 Pulse Coherence Doppler Error: Not applicable

3.11.2 Dynamic Signal Strength Range: Not applicable

3.11.3 Spectral Skew: Not applicable

3.11.4 Carrier Line Width: Not applicable

3.11.5 Interline Noise: Not applicable

3.11.6 Frequency Locking Range: Not applicable

4.0 QUALITY/RELIABILITY DATA

4.1 Reliability Characteristics

4.1.1 Design Reliability: Mission duration of 1.5 hours shall be 0.995

4.1.2 Operational Stability: Not specified

4.1.3 Service Life: Not specified

HERLEY INDUSTRIES, INC.
C-BAND RADAR TRACKING TRANSPONDER

Manufacturer's Model Designation:	**MD401C-1**
Manufacturer's Part Number:	**500003-1**
Military Designation:	**None**
Federal Stock Number:	**None**

1.0 GENERAL DESCRIPTION

The model MD401C-1 is a general purpose, precision C-band radar augmentation device with a high sensitivity superheterodyne receiver and magnetron transmitter. Used primarily for range safety functions, the model MD400C is suitable for use in both manned and unmanned vehicles. This transponder is applicable to precision tracking of aircraft, sounding rockets, space-launch vehicles, missiles, and target drones, both sea and airborne. This unit is fully tuneable over the 5.4 to 5.9 GHz range, while being quite small (less than 35 cubic inches) and lightweight (less than 51 ounces), making it suitable for use in applications requiring small size with high power. Environmental requirements are to MIL-STD-810.

2.0 DEVELOPMENT AND UTILIZATION

The model MD401C-1 was developed by Herley Industries, Inc. with company funds to fill the need for a rugged, precision radar transponder, whose modern circuitry greatly improves reliability and performance. The model MD401C-1 is a family of transponders with many minor variations to suit each customer's unique system requirements. Versions of the model MD401C-1 have been qualified by the McDonnell Douglas Space Systems Company with the USAF Space Division, and Israeli Aircraft Industries. Other qualifications are in progress. It is being used on such programs as aircraft training pods at Eglin Air Force Base, Florida, the joint U.S./Israel Arrow missile program and the Delta, Titan, Atlas, Titan/Centaur, and Atlas/Centaur Space Launch Vehicles.

3.0 **TECHNICAL SPECIFICATIONS**

3.1 **General Characteristics**

3.1.1 Frequency Range: 5.4 to 5.9 GHz

3.1.2 Trigger Sensitivity: -70 dBm minimum for 99 percent reply

3.1.3 Peak Power Output: 400 watts minimum

3.1.4 Standard Reply Delay: Adjustable from 1.5 to 6.0 microseconds

3.1.5 Interrogation Pulse Coding: 3.0 to 12.0 microseconds

3.1.6 Pulse Repetition Frequency Response Range: 100 to 3000 pps nominal

3.1.7 Recovery Time: 50 microseconds maximum

3.1.8 Nominal Operating Voltage: 22 to 32 Vdc

3.1.9 Operating Stabilization Time: 3 minutes maximum

3.2 **Receiver/Decoder Characteristics**

3.2.1 Design Type: Superheterodyne

3.2.2 Frequency Range: 5.4 to 5.9 GHz

3.2.3 Receiver Tuning: Mechanical (4 screws)

3.2.4 Frequency Stability: ±3.0 MHz after a 3 minute warmup

3.2.5 3 dB Bandwidth: 11.0 ±3.0 MHz

3.2.6 40 dB Bandwidth: Not specified

3.2.7 Off-Frequency and Image Rejection: 60 dB minimum

3.2.8 Dynamic Signal Range: +20 to -70 dBm

3.2.9 Maximum Input Signal: +20 dBm

3.2.10 Pulse Width Acceptance: 0.25 to 5.0 microseconds in single pulse mode, 0.25 to 1.0 microsecond in the double pulse mode

3.2.11 Pulse Rise Time Acceptance: 0.100 microsecond maximum

3.2.12 Pulse Code Spacing Range: 3.0 to 12.0 microseconds

3.2.13 Decoder Accept Limits: ±0.150 microsecond

3.2.14 Decoder Reject Limits: ±0.300 microsecond

3.2.15 Delay Decision Pulse Trigger Point (Percent of rise time): 50 percent

3.3 **Transmitter Characteristics**

3.3.1 Design Type: Magnetron

3.3.2 Frequency Range: 5.4 to 5.9 GHz

3.3.3 Transmitter Tuning: Mechanical (1 screw)

3.3.4 Frequency Stability: ±2.5 MHz plus ±50 KHz/°C maximum

3.3.5 Peak Power Output: 400 watts minimum

3.3.6 Power Spectrum: Bandwidth (MHz) is less than 3.0/pulse width (in microseconds) measured at the 1/4 power level points.

3.3.7 Spectral Purity: Not specified

3.3.8 Spurious Radiation: Not specified

3.3.9 Pulse Repetition Rate Range: 100 to 3000 pps

3.3.10 Duty Cycle: Up to 0.002 (0.2 percent)

3.3.11 Pulse Width: 0.5 ±0.1 microsecond

3.3.12 Pulse Width Jitter: 0.01 microsecond maximum

3.3.13 Pulse Amplitude Variation: Not specified

3.3.14 Pulse Rise Time: 0.100 microsecond maximum

3.3.15 Pulse Fall Time: 0.200 microsecond maximum

3.4 **Delay Characteristics**

3.4.1 Absolute System Delay Variation: Not specified

3.4.2 Reply Delay Variations

3.4.2.1 Signal Strength Variation: 0.03 microsecond maximum for input signals between +10 and -65 dBm

3.4.2.2 Interrogation Rate Variation: Not specified

3.4.2.3 Interrogation Frequency Variation: Not specified

3.4.2.4 Pulse Code Spacing Variation: Not specified

3.4.2.5 Decision Pulse Rise Time Variation: Not specified

3.4.2.6 Input Power Potential Variation: Not specified

3.4.2.7 Temperature Variation: Not specified

3.4.2.8 Acceleration Variation: Not specified

3.4.3 Reply Delay Jitter: 0.02 microsecond maximum peak to peak for 0 dBm to -65 dBm

3.5 **Radio Frequency Load Matching Characteristics**

3.5.1 Input Impedance: 50 ohm

3.5.2 Output Impedance: 50 ohm

3.5.3 Open-Short Survival: Built in to provide antenna mismatch protection

3.5.4 Voltage Standing Wave Ratio of the Load: 2:1 maximum

3.5.5 Duplexer Type: Four-port circulator

3.6 **Power Supply Characteristics**

3.6.1 Design Type: Series pass regulator with chopper

3.6. Input Voltage Range: 22 to 32 Vdc

3.6.3 Under Voltage/Over Voltage Protection: Normal regulation to 20.5 volts input/higher voltage components used

3.6.4 Input Current, Quiescent: 0.600 amp nominal

3.6.5 Input Current, Interrogated at 1000 pps: 1.10 amp maximum

3.6.6 Transient Protection: Provided by regulator portion of power supply

3.6.7 Grounding and Isolation: Power leads isolated from chassis by 1 meg ohm minimum

3.6.8 Standby Operation: None

3.7 **Design Characteristics**

3.7.1 Response to Valid Interrogation: Better than 99 percent for all valid interrogations

3.7.2 Random Triggering and Free-Running: Less than 10 pps under all conditions

3.7.3 Transmitter-Receiver Frequency Separation: 50 MHz minimum

3.7.4 Off-Band Rejection Filter: Provided with the three section preselector

3.7.5 Mixer Diode Protection: Limited to +20 dBm input

3.7.6 Power Delay Time: 45 seconds nominal

3.7.7 Reverse Polarity Protection: Provided with series diode

3.7.8 Over-Interrogation Protection: Provided with internal integrator circuit

3.7.9 Lock-Out Protection: Receiver blanked for 50 micro-seconds maximum during transmit time

3.8 **Environmental Specifications**

3.8.1 Operating Temperature: -54°C (-66°F) to +75°C (+167°F)

3.8.2 Nonoperating Temperature: -62.2°C (-80°F) to +75°C (+167°F)

3.8.3 Pressure Altitude: 760 mm of mercury (sea level) to 0.04 mm of mercury (230,000 feet altitude)

3.8.4 Shock: 125g sawtooth for 11 milliseconds duration, operating

3.8.5 Sine Vibration: 5 to 25 Hz, 0.40 inch double amplitude; 25 to 2000 Hz, 15g

3.8.6 Random Vibration: $0.0009g^2$ rms/Hz up to 150 Hz. Increases to $0.20g^2$ rms/Hz from 600 to 800 Hz; decreases to $0.02g^2$ rms/Hz at 2000 Hz

3.8.7 Acoustical Noise: Not specified

3.8.8 Random Noise: Not specified

3.8.9 Acceleration: 125g applied along any axis for 3 minute

3.8.10 Humidity: Any, up to 100 percent including condensation due to temperature changes

3.8.11 Salt Fog Atmosphere: Not specified

3.8.12 Rain: Not specified

3.8.13 Sand and Dust: Not specified

3.8.14 Fungus: Not specified

3.8.15 Missile Fuel Compatibility: Not specified

3.8.16 Electromagnetic Interference: Methods CE03, CE06, CE07, CS01, CS02, CS06, RE03, RS02, and RS03 of MIL-STD 461

3.9 **Physical/Mechanical Characteristics**

3.9.1 Form: Rectangular

3.9.2 Dimensions, Excluding Protrusions: 4.80L X 3.93W X 2.90H (12.19 X 9.98 X 7.37 cm)

3.9.3 Displacement Volume: 35 cubic inches (574 cubic cm) nominal

3.9.4 Weight: 51 ounces (1.45 kgm) maximum

3.9.5 Pressurization: Sealed at sea level

3.9.6 Mounting Attitude: Any

3.9.7 Mounting Dimensions: 4 holes, 2 in each line on the front and back of the unit. Clearance holes for #8 screws.

3.9.8 Power and Test Connector Type: MC-14H-10-6PN

3.9.9 Radio Frequency Connector Type: TNC female

3.9.10 Type of External Controls: Slotted screwdriver adjust with removal of a seal screw

3.9.11 Pressurization Fitting Type: Schraeder valve mounted on unit

3.9.12 Grounding and Bonding: Entire case at ground potential

3.9.13 Mounting Bracket: None

3.9.14 Mounting Type: Provision for four #8 screws

3.10 **Auxiliary Functions**

3.10.1 External Output Signal Provisions: None

3.10.2 External Input Signal Provisions: None

3.10.3 External Adjustments: Receiver tune, transmitter tune (provided with removal of seal screws)

3.10.4 External Test Points: Power connector; pin D - video test

3.10.5 Internal Test Points: Provided for easy signal tracing

3.11 **Coherent Velocity Specifications**

3.11.1 Pulse Coherence Doppler Error: Not applicable

3.11.2 Dynamic Signal Strength Range: Not applicable

3.11.3 Spectral Skew: Not applicable

3.11.4 Carrier Line Width: Not applicable

3.11.5 Interline Noise: Not applicable

3.11.6 Frequency Locking Range: Not applicable

4.0 **QUALITY/RELIABILITY DATA**

4.1 **Reliability Characteristics**

4.1.1 Design Reliability: The mean time between failures (MTBF) is 5000 hours

4.1.2 Operational Stability: Not specified

4.1.3 Service Life: Not specified

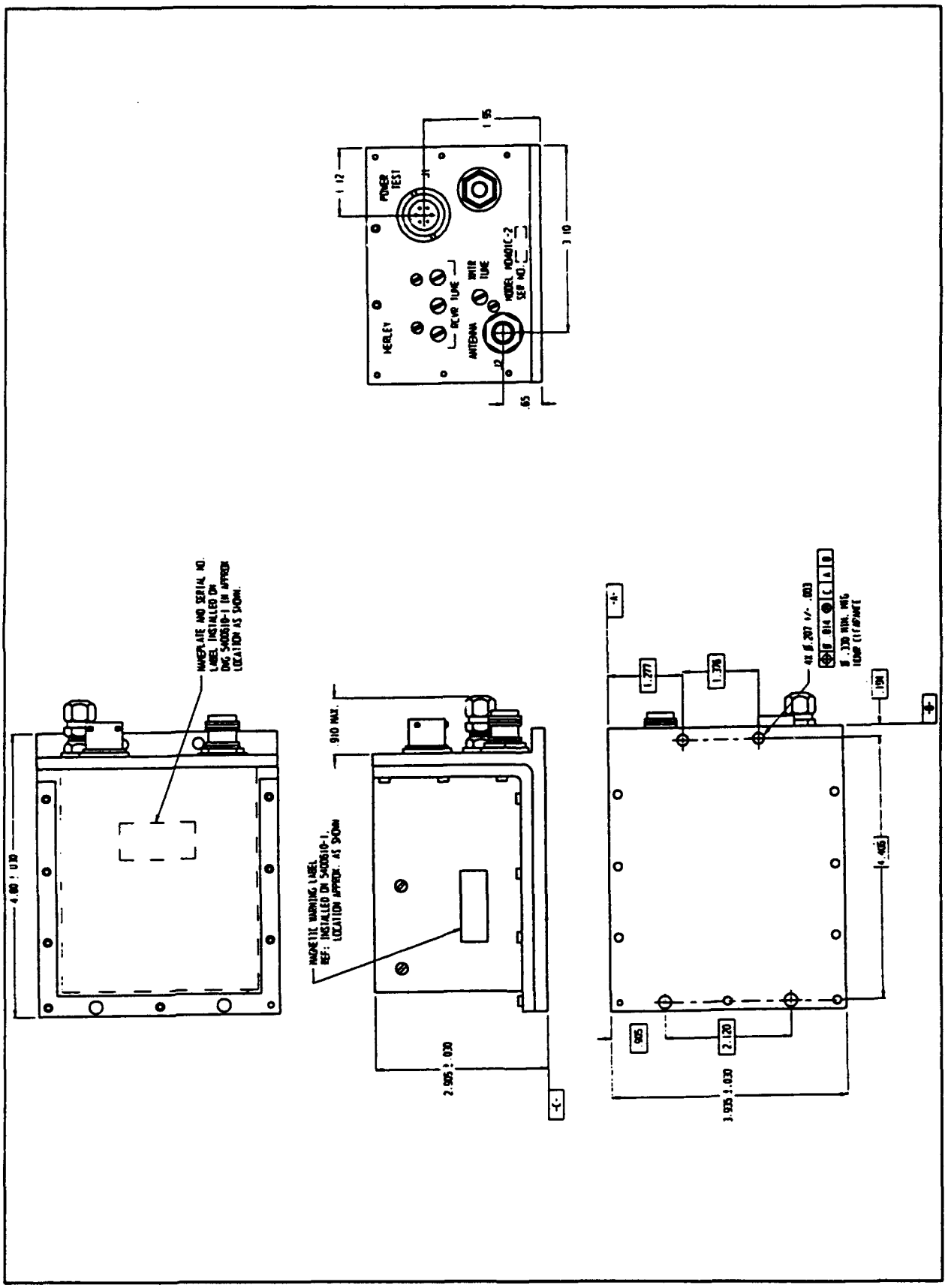

Figure 2-5. MD401C outline drawing - all versions.

HERLEY INDUSTRIES, INC.
C-BAND RADAR TRACKING TRANSPONDER

Manufacturer's Model Designation:	**MD401C-2**
Manufacturer's Part Number:	**500003**
Military Designation:	**None**
Federal Stock Number:	**None**
Martin Marietta Aerospace Systems P/N:	**PD 6480751-019**

1.0 GENERAL DESCRIPTION

The model MD401C-2 is a High Rel, precision C-band radar augmentation device with a high sensitivity superheterodyne receiver and magnetron transmitter. Used primarily for range safety functions, the model MD400C is suitable for use in both manned and unmanned vehicles. This transponder is applicable to precision tracking of aircraft, sounding rockets, space-launch vehicles, missiles, and target drones, both sea and airborne. This unit is fully tuneable over the 5.4 to 5.9 GHz range, while being quite small (less than 35 cubic inches) and lightweight (less than 51 ounces), making it suitable for use in applications requiring small size with high power. The model MD401C-2 was specifically designed to the space level parts and service environmental requirements of large space-launch vehicles. Environmental requirements are to the MMAS PD for the Titan IV Launch Vehicle.

2.0 DEVELOPMENT AND UTILIZATION

The model MD401C-2 was developed by Herley Industries, Inc. to fill the need for a rugged, precision radar transponder, whose modern circuitry greatly improves reliability and performance. The model MD401C-2 is a family of transponders with many minor variations to suit each customer's unique system requirements. Versions of the model MD401C-2 have been qualified by McDonnell Douglas Space System Company and are currently in process for General Dynamics Space Systems Division as well as Martin Marietta Aerospace. It is being used on such programs as the Delta and Titan 34 Launch Vehicles and will be flown on the Titan IV, Atlas, Atlas/Centaur, and Titan/Centaur vehicles.

3.0 TECHNICAL SPECIFICATIONS

3.1 General Characteristics

3.1.1 Frequency Range: 5.4 to 5.9 GHz

3.1.2 Trigger Sensitivity: -70 dBm minimum for 99 percent reply

3.1.3 Peak Power Output: 400 watts minimum, 1000 watts maximum

3.1.4 Standard Reply Delay: Settings from 1.5 to 6.0 microseconds. Set to 2.5 microseconds

3.1.5 Interrogation Pulse Coding: Settings from 3.0 to 12.0 microseconds. Set to 6.0 microseconds

3.1.6 Pulse Repetition Frequency Response Range: 100 to 2600 pps nominal

3.1.7 Recovery Time: 50 microseconds maximum

3.1.8 Nominal Operating Voltage: 22 to 32 Vdc

3.1.9 Operating Stabilization Time: 5 minutes maximum at ambient temperature

3.2 Receiver/Decoder Characteristics

3.2.1 Design Type: Superheterodyne

3.2.2 Frequency Range: Tunable from 5.4 to 5.9 GHz, set to 5690 MHz

3.2.3 Receiver Tuning: Mechanical (4 screws)

3.2.4 Frequency Stability: ±3.0 MHz after a 5 minute warmup

3.2.5 3 dB Bandwidth: 11.0 ±3.0 MHz

3.2.6 40 dB Bandwidth: 60 MHz maximum

3.2.7 Off-Frequency and Image Rejection: 60 dB minimum

3.2.8 Dynamic Signal Range: +20 to -70 dBm

3.2.9 Maximum Input Signal: +20 dBm

3.2.10 Pulse Width Acceptance: 0.25 to 5.0 microseconds in single pulse mode, 0.25 to 1.0 microsecond in the double pulse mode

3.2.11 Pulse Rise Time Acceptance: 0.100 microsecond maximum

3.2.12 Pulse Code Spacing Range: Settings from 3.0 to 12.0 microseconds. Set to 6.0 microseconds

3.2.13 Decoder Accept Limits: ±0.150 microsecond

3.2.14 Decoder Reject Limits: ±0.300 microsecond

3.2.15 Delay Decision Pulse Trigger Point (Percent of rise time): 50 percent

3.3 **Transmitter Characteristics**

3.3.1 Design Type: Magnetron

3.3.2 Frequency Range: Tunable from 5.4 to 5.9 GHz, set to 5765 MHz

3.3.3 Transmitter Tuning: Mechanical (1 screw)

3.3.4 Frequency Stability: ±2.5 MHz ±50 KHz/°C maximum

3.3.5 Peak Power Output: 400 watts minimum, 1000 watts maximum

3.3.6 Power Spectrum: Bandwidth (MHz) is less than 3.0/pulse width (in microseconds) measured at the 1/4 power level points.

3.3.7 Spectral Purity: First side lobes 7 dB below peak main lobe minimum. First nulls 9 dB below peak main lobe minimum.

3.3.8 Spurious Radiation: Not specified

3.3.9 Pulse Repetition Rate Range: 100 to 2600 pps

3.3.10 Duty Cycle: Up to 0.002 (0.2 percent)

3.3.11 Pulse Width: 0.5 ±0.1 microsecond

3.3.12 Pulse Width Jitter: 0.01 microsecond maximum

3.3.13 Pulse Amplitude Variation: Not specified

3.3.14 Pulse Rise Time: 0.100 microsecond maximum

3.3.15 Pulse Fall Time: 0.200 microsecond maximum

3.4 **Delay Characteristics**

3.4.1 Absolute System Delay Variation: Not specified

3.4.2 Reply Delay Variations

3.4.2.1 Signal Strength Variation: 0.03 microsecond maximum for input signals between 0 and -60 dBm

3.4.2.2 Interrogation Rate Variation: 0.016 microsecond maximum for prf from 160 to 2600 pps

3.4.2.3 Interrogation Frequency Variation: Not specified

3.4.2.4 Pulse Code Spacing Variation: Not specified

3.4.2.5 Decision Pulse Rise Time Variation: Not specified

3.4.2.6 Input Power Potential Variation: Not specified

3.4.2.7 Temperature Variation: Not specified

3.4.2.8 Acceleration Variation: Not specified

3.4.3 Reply Delay Jitter: 0.02 microsecond maximum peak to peak for 0 dBm to -55 dBm, and 0.05 microsecond maximum peak to peak for -55 dBm to -65 dBm

3.5 **Radio Frequency Load Matching Characteristics**

3.5.1 Input Impedance: 50 ohm

3.5.2 Output Impedance: 50 ohm

3.5.3 Open-Short Survival: Built in to provide antenna mismatch protection

3.5.4 Voltage Standing Wave Ratio of the Load: 2:1 maximum

3.5.5 Duplexer Type: Four-port circulator

3.6 **Power Supply Characteristics**

3.6.1 Design Type: Series pass regulator with chopper

3.6.2 Input Voltage Range: 22 to 32 Vdc

3.6.3 Under Voltage/Over Voltage Protection: Normal regulation to 20.5 volts input/higher voltage components used

3.6.4 Input Current, Quiescent: 0.600 amp nominal

3.6.5 Input Current, Interrogated at 1000 pps: 1.00 amp nominal

3.6.6 Transient Protection: Provided by regulator portion of power supply

3.6.7 Grounding and Isolation: Power leads isolated from chassis by 1 meg ohm minimum

3.6.8 Standby Operation: None

3.7 **Design Characteristics**

3.7.1 Response to Valid Interrogation: Better than 99 percent for all valid interrogations

3.7.2 Random Triggering and Free Running: Less than 10 pps under all conditions

3.7.3 Transmitter-Receiver Frequency Separation: 50 MHz minimum

3.7.4 Off-Band Rejection Filter: Provided with the three section preselector

3.7.5 Mixer Diode Protection: Limited to +20 dBm input

3.7.6 Power Delay Time: 45 seconds nominal

3.7.7 Reverse Polarity Protection: Provided with series diode

3.7.8 Over-Interrogation Protection: Provided with internal integrator circuit

3.7.9 Lock-Out Protection: Receiver blanked for 50 micro-seconds maximum during transmit time

3.8 **Environmental Specifications**

3.8.1 Operating Temperature: -34°C (-29.2°F) to +71°C (+160°F)

3.8.2 Nonoperating Temperature: -62.2°C (-80°F) to +75°C (+167°F)

3.8.3 Pressure Altitude: 760 mm of mercury (sea level) to 0.04 mm of mercury (230,000 feet altitude).

3.8.4 Shock: Pyro shock of 2720g at 2000 Hz, Q=10

3.8.5 Sine Vibration: Not specified

3.8.6 Random Vibration: 43.61g rms

3.8.7 Acoustical Noise: Not specified

3.8.8 Random Noise: Not specified

3.8.9 Acceleration: Not specified

3.8.10 Humidity: Any, up to 100 percent including condensation because of temperature changes

3.8.11 Salt Fog Atmosphere: Not specified

3.8.12 Rain: Not specified

3.8.13 Sand and Dust: Not specified

3.8.14 Fungus: Not specified

3.8.15 Missile Fuel Compatibility: Not specified

3.8.16 Electromagnetic Interference: Methods CE01, CE03, CE06, CE07, CS01, CS02, CS03, CS04, CS05, CS06, RE02, RS02, and RS03 of MIL-STD 461

3.9 **Physical/Mechanical Characteristics**

3.9.1 Form: Rectangular

3.9.2 Dimensions, Excluding Protrusions: 4.80L X 3.93W X 2.90H (12.19 X 9.98 X 7.37 cm)

3.9.3 Displacement Volume: 35 cubic inches (574 cubic cm) nominal

3.9.4 Weight: 51 ounces (1.45 kgm) maximum

3.9.5 Pressurization: Sealed at sea level

3.9.6 Mounting Attitude: Any

3.9.7 Mounting Dimensions: 4 holes, 2 in each line on the front and back of the unit. Clearance holes for #8 screws.

3.9.8 Power and Test Connector Type: MC-14H-10-6PN

3.9.9 Radio Frequency Connector Type: TNC female

3.9.10 Type of External Controls: Slotted screwdriver adjust with removal of a seal screw

3.9.11 Pressurization Fitting Type: Schraeder valve mounted on unit

3.9.12 Grounding and Bonding: Entire case at ground potential

3.9.13 Mounting Bracket: None

3.9.14 Mounting Type: Provision for four #8 screws

3.10 **Auxiliary Functions**

3.10.1 External Output Signal Provisions: None

3.10.2 External Input Signal Provisions: None

3.10.3 External Adjustments: Receiver tune, transmitter tune (provided with removal of seal screws)

3.10.4 External Test Points: None

3.10.5 Internal Test Points: Provided for easy signal tracing

3.11 **Coherent Velocity Specifications**

3.11.1 Pulse Coherence Doppler Error: Not applicable

3.11.2 Dynamic Signal Strength Range: Not applicable

3.11.3 Spectral Skew: Not applicable

3.11.4 Carrier Line Width: Not applicable

3.11.5 Interline Noise: Not applicable

3.11.6 Frequency Locking Range: Not applicable

4.0 **QUALITY/RELIABILITY DATA**

4.1 **Reliability Characteristics**

4.1.1 Design Reliability: The mean time between failures (MTBF) is 5000 hours

4.1.2 Operational Stability: Not specified

4.1.3 Service Life: Not specified

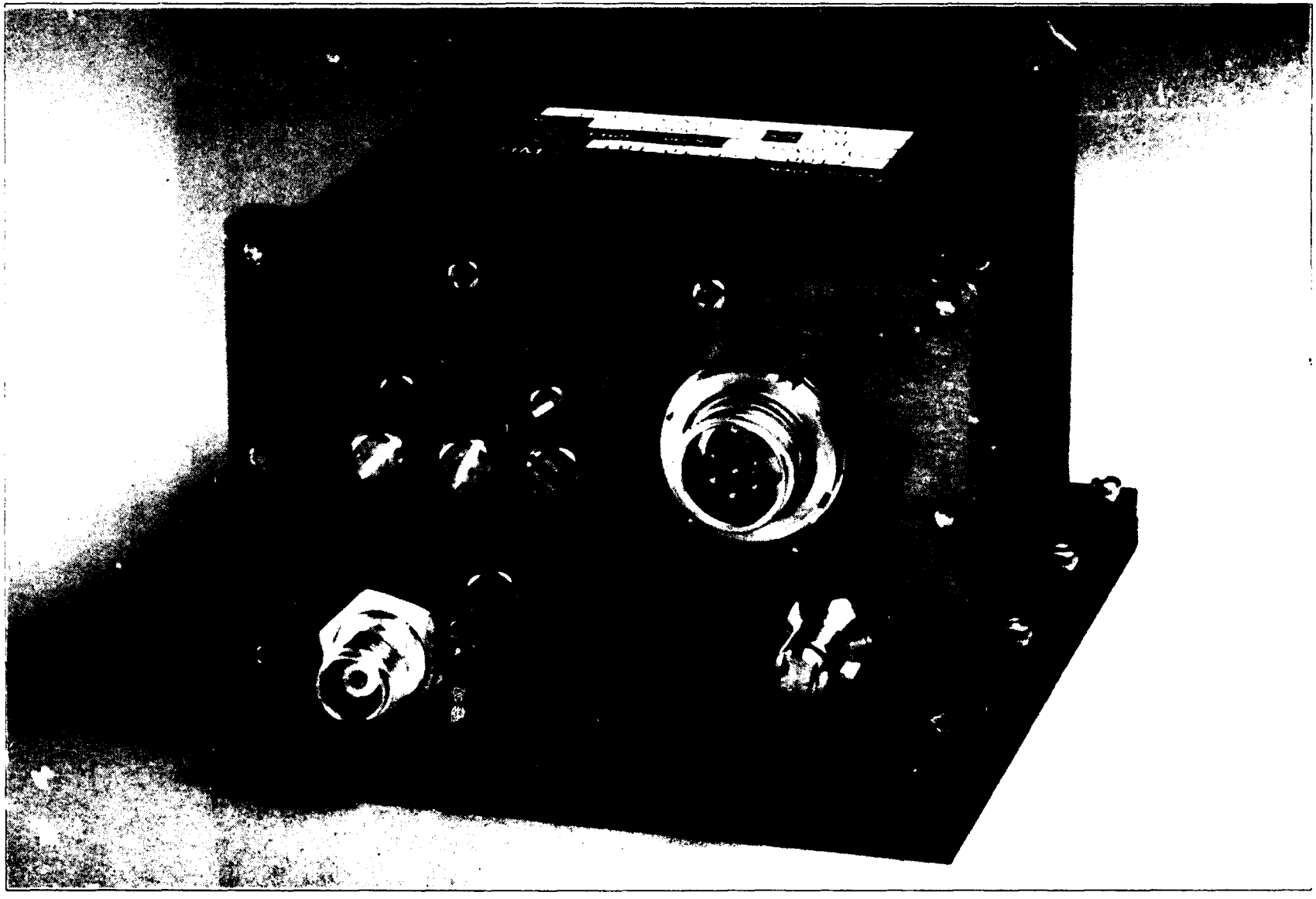

Figure 2-6. Model MD401C-2 C-Band Transponder.

3. VEGA PRECISION LABORATORIES, INC.
800 FOLLIN LANE
VIENNA, VIRGINIA 22180-4994
PHONE: (703) 938-6300

I-BAND RADAR TRACKING TRANSPONDERS

Model 319X-9
Model 366X-1
Model 380X

VEGA PRECISION LABORATORIES
I-BAND NONCOHERENT RADAR TRACKING TRANSPONDER

Manufacturer's Model Designation:	**319X-9**
Manufacturer's Part Number:	**303485-1**
Military Designation:	**Not assigned**
Federal Stock Number:	**Not assigned**

1.0 GENERAL DESCRIPTION

The model 319X-9 transponder is a medium power unit designed to be used in conjunction with I-band tracking radars. It offers the test-range users a low-cost approach to tracking airborne vehicles.

Either single-pulse or double-pulse interrogation can be selected. The transponder responds to valid interrogations with a single-pulse reply. To better meet mission requirements, this I-band transponder is interchangeable in weight, outline, footprint, and electrical interface with the G-band 302C-2.

2.0 DEVELOPMENT AND UTILIZATION

This unit was developed by Vega with company funds.

3.0 TECHNICAL SPECIFICATIONS

3.1 General Characteristics

3.1.1 Frequency Range: Rx 9.0 to 9.5 GHz, Tx 9.2 to 9.5 GHz

3.1.2 Trigger Sensitivity: -65 dBm minimum

3.1.3 Peak Power Output: 400 watts typical, 300 watts minimum

3.1.4 Standard Reply Delay: 2.0 to 6.0 microseconds, adjustable

3.1.5 Interrogation Pulse Coding: Single or double pulse, selectable

3.1.6 Pulse Repetition Frequently Response Range: 10 to 2600 pps

3.1.7 Recovery Time: 50 microseconds maximum

3.1.8 Nominal Operating Voltage: 24 to 30 Vdc

3.1.9 Operating Stabilization Time: 3 minutes

3.2 **Receiver/Decoder Characteristics**

3.2.1 Design Type: Superheterodyne

3.2.2 Frequency Range: 9.0 to 9.5 GHz

3.2.3 Receiver Tuning: Single local oscillator tuning control and three preselector tuning controls accessible from exterior of unit

3.2.4 Frequency Stability: ±2 MHz

3.2.5 3 dB Bandwidth: 11 ±3 MHz

3.2.6 40 dB Bandwidth: 90 MHz typical

3.2.7 Off-Frequency and Image Rejection: Image rejection 60 dB minimum

3.2.8 Dynamic Signal Range: +20 to -65 dBm

3.2.9 Maximum Input Signal: +20 dBm

3.2.10 Pulse Width Acceptance: 0.25 to 5.0 microseconds, single pulse. 0.25 to 1.0 microsecond, double pulse

3.2.11 Pulse Rise Time Acceptance: 0.1 microsecond or less

3.2.12 Pulse Code Spacing: 3.0 to 12.0 microseconds, adjustable

3.2.13 Decoder Accept Limits: ±0.15 microsecond

3.2.14 Decoder Reject Limits: ±0.30 microsecond

3.2.15 Delay Decision Pulse Trigger Point (Percent of rise time): Not specified

3.3 **Transmitter Characteristics**

3.3.1 Design Type: Magnetron

3.3.2 Frequency Range: 9.2 to 9.5 GHz

3.3.3 Transmitter Tuning: Single control accessible from exterior of unit

3.3.4 Frequency Stability: ±3.0 MHz under all conditions except temperature. During changes in ambient temperature, frequency drift will not exceed 50 KHZ/°C

3.3.5 Peak Power Output: 400 watts typical, 300 watts minimum

3.3.6 Power Spectrum: The RF bandwidth in MHz will not exceed 3.0/pulse width in microseconds measured at the quarter power point.

3.3.7 Spectral Purity: Not specified

3.3.8 Spurious Radiation: Not specified

3.3.9 Pulse Repetition Rate Range: 10 to 2600 pulses per second

3.3.10 Duty Cycle: 0.002 maximum

3.3.11 Pulse Width: 0.5 ±0.1 microsecond

3.3.12 Pulse Width Jitter: 0.01 microsecond maximum

3.3.13 Pulse Amplitude Variation: Not specified

3.3.14 Pulse Rise Time (10 to 90 percent): 0.1 microsecond maximum

3.3.15 Pulse Fall Time (90 to 10 percent): 0.2 microsecond maximum

3.4 **Delay Characteristics**

3.4.1 Absolute System Delay Variation: Maximum variation will not exceed 0.05 microsecond for signal levels of 0 to -62 dBm

3.4.2 Reply Delay Variations

3.4.2.1 Signal Strength Variation: Not specified

3.4.2.2 Interrogation Rate Variation: Not specified

3.4.2.3 Interrogation Frequency Variation: Not specified

3.4.2.4 Pulse Code Spacing Variation: Not specified

3.4.2.5 Decision Pulse Rise Time Variation: Not specified

3.4.2.6 Input Power Potential Variation: Not specified

3.4.2.7 Acceleration Variation: Not specified

3.4.3 Reply Delay Jitter: ±0.05 microsecond at an input signal level of -55 to -65 dBm. ±0.02 microsecond at input signal level of 0 to -55 dBm

3.5 **Radio Frequency Load Matching Characteristics**

3.5.1 Input Impedance: 50 ohm nominal

3.5.2 Output Impedance: 50 ohm nominal

3.5.3 Open/Short Survival: Transmitter shall meet all requirements after application and removal of either a short or open circuit at the antenna terminal.

3.5.4 Voltage Standing Wave Ratio of Load: Will operate in conjunction with an antenna system having a VSWR of 2:1 at all phase angles.

3.5.5 Duplexer Type: Four-port ferrite circulator

3.6 **Power Supply Characteristics**

3.6.1 Design Type: Primary regulated dc-dc converter

3.6.2 Input Voltage Range: 24 to 30 Vdc

3.6.3 Under Voltage/Over Voltage Protection: Not specified

3.6.4 Input Current, Quiescent: 1.0 ampere maximum

3.6.5 Input Current, Interrogated at 1000 pulses per second: 1.6 ampere maximum

3.6.6 Transient Protection: MIL-E-26144

3.6.7 Grounding and Isolation: Input power lines isolated from chassis ground

3.6.8 Standby Operation: Same as quiescent

3.7 **Design Characteristics**

3.7.1 Response to Valid Interrogations: Shall trigger at least 99 percent replies to signals at level between 0 to -65 dBm applied to the transponder antenna connector

3.7.2 Random Triggering: Will not exceed 10 pulses per second

3.7.3 Transmitter-Receiver Frequency Separation: 50 MHz minimum

3.7.4 Off-Band Rejection Filter: Three section preselector and tuned IF amplifier

3.7.5 Mixer Diode Protection: Preselector protects diode from off frequency RF.

3.7.6 Power Delay Time: 40 seconds

3.7.7 Reverse Polarity Protection: Provided on 28 Vdc line

3.7.8 Over-Interrogation Protection: Provided to limit transmitter duty cycle to 0.002

3.7.9 Lock-Out Protection: Provides for no response during 50 microseconds recovery time of transponder

3.8 **Environmental Specifications**

3.8.1 Operating Temperature: -37°C to +75°C (-35°F to +167°F)

3.8.2 Nonoperating Temperature: -62°C to +75°C (-80°F to +167°F)

3.8.3 Pressure Altitude: 760 mm of mercury to 0.04 mm of mercury (230,000 feet altitude)

3.8.4 Shock: 125g in any direction, 3 shocks in opposite directions along each axis for 6 milliseconds each

3.8.5 Sine Vibration: 5 to 25 Hz, 0.4 inch double amplitude, 25 to 2500 Hz, 15g

3.8.6 Random Vibration: 0.009 G^2 rms/Hz up to 150 Hz, increase to 0.2 G^2 rms/Hz, from 600 to 800 Hz, decrease to 0.02 G^2 rms/Hz, at 2000 Hz

3.8.7 Acoustical Noise: Not specified

3.8.8 Random Noise: Not specified

3.8.9 Acceleration: 125g applied along any axis for 3 minutes

3.8.10 Humidity: Any, up to 100 percent including condensation because of temperature changes

3.8.11 Salt Fog Atmosphere: Not specified

3.8.12 Rain: Not specified

3.8.13 Sand and Dust: Not specified

3.8.14 Fungus: Not specified

3.8.15 Missile Fuel Compatibility: Not specified

3.8.16 Electromagnetic Compatibility: MIL-I-26600

3.9 **Physical/Mechanical Characteristics**

3.9.1 Form: Rectangular Solid

3.9.2 Dimensions, Excluding Protrusions: 4.27 x 4.68 x 2.26 inches

3.9.3 Displacement Volume: 43 cubic inches

3.9.4 Weight: 45 ounces maximum

3.9.5 Pressurization: Not specified

3.9.6 Mounting Attitude: Any

3.9.7 Mounting Dimensions: 6 holes 0.173 diameter, 1 hole on centerline front and rear spaced 4.69 inches apart. 1 hole 1.84 inches either side of centerline front and rear.

3.9.8 Power and Test Connector: MS3114H8C-4P (Mates with MS3116E8-4S)

3.9.9 Radio Frequency Connector: TNC female

3.9.10 Type of External Controls: None

3.9.11 Pressurization Fitting Type: Schraeder type with protective cap

3.9.12 Grounding and Bonding: Not necessary

3.9.13 Mounting Bracket: Not specified

3.9.14 Mounting Type: Not specified

3.10 **Auxiliary Functions**

3.10.1 External Output Signal Provisions: Not specified

3.10.2 External Input Signal Provisions: Not specified

3.10.3 External Adjustments: Transmitter tuning, receiver tuning, sensitivity, decoder, and delay

3.10.4 External Test Points: Not specified

3.10.5 Internal Test Points: Provided to allow rapid isolation of malfunction to a particular module

3.11 **Coherent Velocity Specifications**

3.11.1 Pulse Coherence Doppler Error: Not applicable

3.11.2 Dynamic Signal Strength Range: Not applicable

3.11.3 Spectral Skew: Not applicable

3.11.4 Carrier Line Width: Not applicable

3.11.5 Interline Noise: Not applicable

3.11.6 Frequency Locking Range: Not applicable

4.0 **QUALITY/RELIABILITY DATA**

4.1 **Reliability Characteristics**

4.1.1 Design Reliability: Not specified

4.1.2 Operational Stability: Not specified

4.1.3 Service Life: Unlimited with minimal servicing and replacement of parts

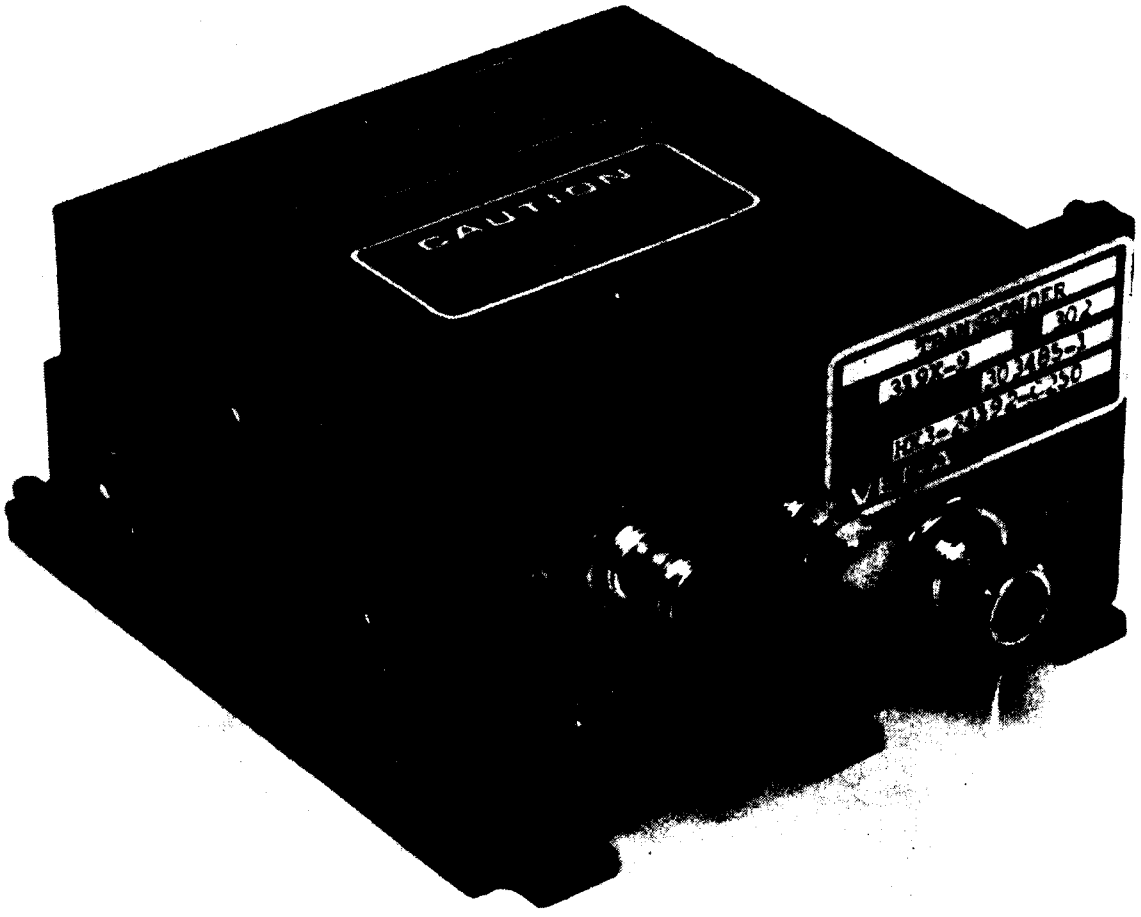

Figure 3-1. Model 319X-9 X-Band Radar Transponder.

VEGA PRECISION LABORATORIES
I-BAND NONCOHERENT RADAR TRACKING TRANSPONDER

Manufacturer's Model Designation:	**366X-1**
Manufacturer's Part Number:	**409553-2**
Military Designation:	**Not assigned**
Federal Stock Number:	**Not assigned**

1.0 GENERAL DESCRIPTION

The model 366X-1 is a I-band radar transponder developed by Vega for use as an enhancement device for I-band tracking radars. This highly accurate miniature transponder uses a solid-state transmitter and super-heterodyne receiver. Its rugged design makes it well suited for applications in a missile or aircraft environment.

2.0 DEVELOPMENT AND UTILIZATION

This unit was developed by Vega for use as an enhancement device for I-band tracking radars.

3.0 TECHNICAL SPECIFICATIONS

3.1 General Characteristics

3.1.1 Frequency Range: 9.1 to 9.4 GHz

3.1.2 Trigger Sensitivity: -55 dBm minimum

3.1.3 Peak Power Output: 20 watts minimum

3.1.4 Standard Reply Delay: 5.0 ±0.1 microsecond

3.1.5 Interrogation Pulse Coding: Single or double pulse, selectable

3.1.6 Pulse Repetition Frequency Response Range: 10 to 2200 pps

3.1.7 Recovery Time: 20 microseconds maximum

3.1.8 Nominal Operating Voltage: 24 to 32 Vdc

3.1.9 Operating Stabilization Time: 5 minutes under room temperature conditions, 15 minutes under cold temperature conditions

3.2 **Receiver/Decoder Characteristics**

3.2.1 Design Type: Superheterodyne

3.2.2 Frequency Range: 9.1 to 9.4 GHz

3.2.3 Receiver Tuning: Single local oscillator tuning control and three preselector tuning controls accessible from exterior of unit

3.2.4 Frequency Stability: ±5 MHz after 3 minute warmup

3.2.5 3 dB Bandwidth: 17 ±5 MHz

3.2.6 40 dB Bandwidth: 90 MHz typical

3.2.7 Off-Frequency and Image Rejection: 50 dB minimum

3.2.8 Dynamic Signal Range: +10 to -50 dBm

3.2.9 Maximum Input Signal: +10 dBm

3.2.10 Pulse Width Acceptance: 0.25 to 1.0 microsecond

3.2.11 Pulse Risetime Acceptance: 0.1 microsecond or less

3.2.12 Pulse Code Spacing: 3.0 to 12.0 microseconds continuously adjustable

3.2.13 Decoder Accept Limits: ±0.15 microsecond

3.2.14 Decoder Reject Limits: ±0.30 microsecond

3.2.15 Delay Decision Pulse Trigger Point (Percent of rise time): Not specified

3.3 **Transmitter Characteristics**

3.3.1 Design Type: Solid State

3.3.2 Frequency Range: 9.1 to 9.4 GHz

3.3.3 Transmitter Tuning: Single control accessible from exterior of unit

3.3.4 Frequency Stability: ±10 MHz for all operating conditions

3.3.5 Peak Power Output: 20 watts minimum

3.3.6 Power Spectrum: The RF bandwidth in MHz will not exceed 2.5/pulse width in microseconds measured at the quarter power point.

3.3.7 Spectral Purity: Not specified

3.3.8 Spurious Radiation: Not specified

3.3.9 Pulse Repetition Rate Range: 10 to 2200 pps

3.3.10 Duty Cycle: 0.00126 maximum

3.3.11 Pulse Width: 0.5 ±0.1 microsecond

3.3.12 Pulse Width Jitter: 0.01 microsecond maximum

3.3.13 Pulse Amplitude Variation: Not specified

3.3.14 Pulse Rise Time (10 to 90 percent): 0.1 microsecond maximum

3.3.15 Pulse Fall Time (90 to 10 percent): 0.2 microsecond maximum

3.4 **Delay Characteristics**

3.4.1 Absolute System Delay Variation: Not specified

3.4.2 Reply Delay Variations

3.4.2.1 Signal Strength Variation: Maximum variation will not exceed 0.05 microsecond for signal levels of 0 to -50 dBm

3.4.2.2 Interrogation Rate Variation: Not specified

3.4.2.3 Interrogation Frequency Variation: Not specified

3.4.2.4 Pulse Code Spacing Variation: Not specified

3.4.2.5 Decision Pulse Rise Time Variation: Not specified

3.4.2.6 Input Power Potential Variation: Not specified

3.4.2.7 Acceleration Variation: Not specified

3.4.3 Reply Delay Jitter: Will not exceed 0.02 microsecond peak to peak for input signal levels of 0 to -45 dBm. Will not exceed 0.05 microsecond for input signal levels of -45 to -55 dBm.

3.5 **Radio Frequency Load Matching Characteristics**

3.5.1 Input Impedance: 50 ohm nominal

3.5.2 Output Impedance: 50 ohm nominal

3.5.3 Open/Short Survival: Transmitter will meet all requirements after application and removal of either a short or an open circuit at the antenna terminal.

3.5.4 Voltage Standing Wave Ratio of Load: Will work into a VSWR of 2:1 typically

3.5.5 Duplexer Type: Four-port ferrite circulator

3.6 **Power Supply Characteristics**

3.6.1 Design Type: Series pass regulator with dc-dc converter

3.6.2 Input Voltage Range: 24 to 32 Vdc

3.6.3 Under Voltage/Over Voltage Protection: Not specified

3.6.4 Input Current, Quiescent: 700 mA maximum

3.6.5 Input Current, Interrogated at 1000 Pulses Per Second: 750 mA maximum

3.6.6 Transient Protection: Per MIL-STD-704A, Category B

3.6.7 Grounding and Isolation: Input power lines isolated from chassis ground

3.6.8 Standby Operation: Same as quiescent

3.7 **Design Characteristics**

3.7.1 Response to Valid Interrogations: Will reply to 99 percent of interrogation signals at all input signal levels of 0 to -55 dBm

3.7.2 Random Triggering: Will not exceed 10 pps under any operating conditions

3.7.3 Transmitter-Receiver Frequency Separation: 50 MHz minimum

3.7.4 Off-Band Rejection Filter: Three-section preselector and tuned IF amplifier

3.7.5 Mixer Diode Protection: Preselector protects diode from off-frequency RF.

3.7.6 Power Delay Time: No delay

3.7.7 Reverse Polarity Protection: Provided to prevent permanent damage upon application of reverse polarity dc input voltage

3.7.8 Over-Interrogation Protection: Provided to limit transmission rate to 2800 pulses per second

3.7.9 Lock-Out Protection: Provides for no response during 20 microseconds recovery time of transponder

3.8 **Environmental Specifications**

3.8.1 Operating Temperature: -40°C to +71°C

3.8.2 Nonoperating Temperature: -40°C to +71°C

3.8.3 Pressure Altitude: 760 mm through 0.04 mm of mercury (230,000 feet)

3.8.4 Shock: 125g in any direction, three shocks in opposite directions along each axis for 6 milliseconds each

3.8.5 Sine Vibration: 5 to 25 Hz, 0.4 inch double amplitude, 25 to 2500 Hz, 15g, 5 minutes sweep up, 5 minutes sweep down

3.8.6 Random Vibration: $0.009g^2$ rms/Hz up to 150 Hz, in increase from 600 to 800 Hz, decrease to $0.02g^2$ to $0.2g^2$ rms/Hz, rms/Hz, at 2000 Hz

3.8.7 Acoustical Noise: Not specified

3.8.8 Random Noise: Not specified

3.8.9 Acceleration: 125g applied along any axis for 3 minutes

3.8.10 Humidity: Any, up to 100 percent including condensation from temperature

3.8.11 Salt Fog Atmosphere: Not specified

3.8.12 Rain: Not specified

3.8.13 Sand and Dust: Not specified

3.8.14 Fungus: Not specified

3.8.15 Missile Fuel Compatibility: Not specified

3.8.16 Electromagnetic Compatibility: Not specified

3.9 **Physical/Mechanical Characteristics**

3.9.1 Form: Rectangular Solid

3.9.2 Dimensions, Excluding Protrusions: 4.25 x 3.90 x 2.00 inches

3.9.3 Displacement Volume: 29.75 cubic inches

3.9.4 Weight: 26 ounces

3.9.5 Pressurization: Not specified

3.9.6 Mounting Attitude: Any

3.9.7 Mounting Dimensions: 4 mounting holes 0.155 inch diameter, spaced 2.1 inches apart on opposite sides

3.9.8 Power and Test Connector: MS27476YO8D35P

3.9.9 Radio Frequency Connector: SMA female

3.9.10 Type of External Controls: None

3.9.11 Pressurization Fitting Type: Adapter Vega part number 203629-1

3.9.12 Grounding and Bonding: Not necessary

3.9.13 Mounting Bracket: None

3.9.14 Mounting Type: Not specified

3.10 **Auxiliary Functions**

3.10.1 External Output Signal Provisions: Not specified

3.10.2 External Input Signal Provisions: Not specified

3.10.3 External Adjustments: Transmitter tuning, local oscillator and preselector

3.10.4 External Test Points: Not specified

3.10.5 Internal Test Points: Provided to allow rapid isolation of a malfunction to a particular module

3.11 **Coherent Velocity Specifications**

3.11.1 Pulse Coherence Doppler Error: Not applicable

3.11.2 Dynamic Signal Strength Range: Not applicable

3.11.3 Spectral Skew: Not applicable

3.11.4 Carrier Line Width: Not applicable

3.11.5 Interline Noise: Not applicable

3.11.6 Frequency Locking Range: Not applicable

4.0 QUALITY/RELIABILITY DATA

4.1 Reliability Characteristics

4.1.1 Design Reliability: 2000 hour mean time between failure, typical

4.1.2 Operational Stability: 16 hour without adjustment

4.1.3 Service Life: Unlimited with proper maintenance

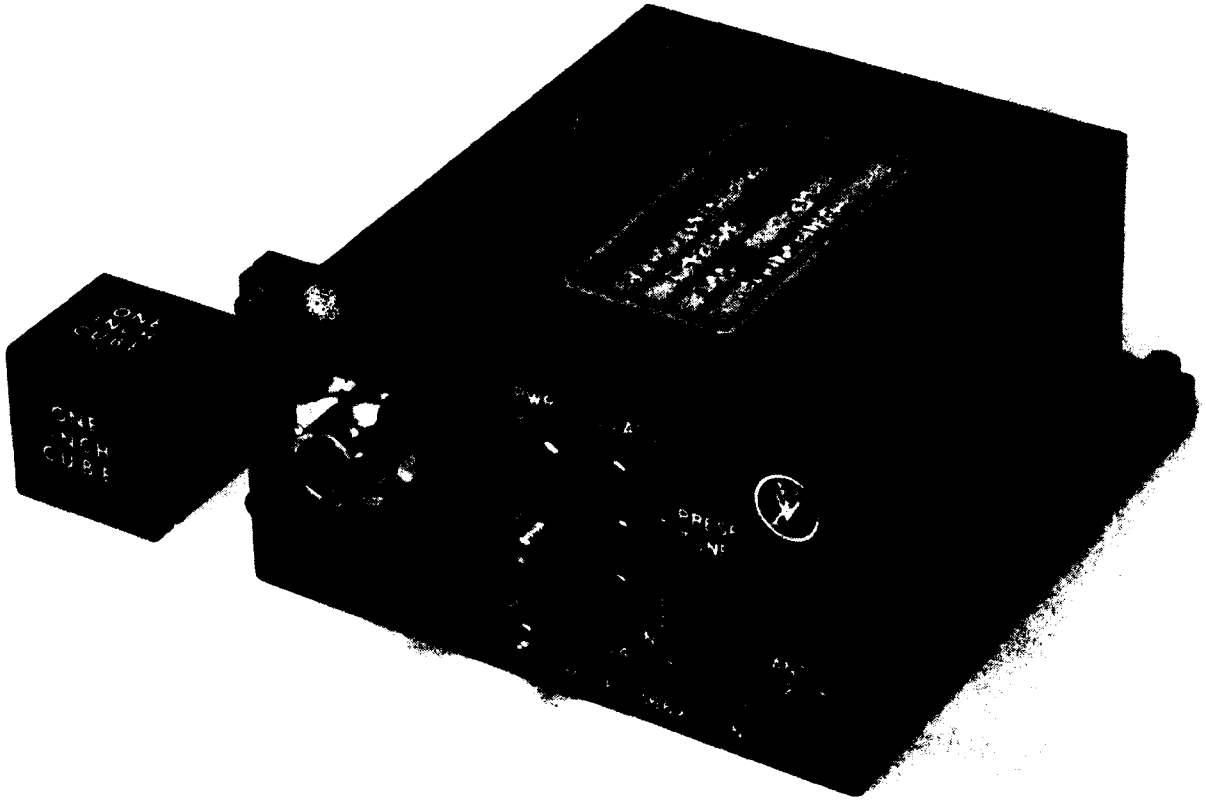

Figure 3-2. Model 366X-1 I-Band Radar Transponder.

VEGA PRECISION LABORATORIES
I-BAND NONCOHERENT RADAR TRACKING TRANSPONDER

Manufacturer's Model Designation:	**380X**
Manufacturer's Part Number:	**408792-1**
Military Designation:	**AN/DPN-90(V)2**
Federal Stock Number:	**Not assigned**

1.0 GENERAL DESCRIPTION

The model 380X transponder is a second generation unit designed to replace the 319X-9. It is a medium power unit used in conjunction with tracking radars and offers the test range users a low-cost approach to tracking airborne vehicles.

This unit features modular construction for ease of repair and was designed for very low cost from its inception. To better meet mission requirements, this I-band transponder is interchangeable in weight, outline, footprint, and electrical interface with the G-band 380C.

2.0 DEVELOPMENT AND UTILIZATION

This unit was developed by Vega under contract with the U.S. Navy as a low-cost replacement for the Vega Model 319X-9.

3.0 TECHNICAL SPECIFICATIONS

3.1 General Characteristics

3.1.1 Frequency Range: Rx 9.0 to 9.5 GHz, Tx 9.2 to 9.5 GHz

3.1.2 Trigger Sensitivity: -65 dBm minimum

3.1.3 Peak Power Output: 300 watts minimum

3.1.4 Standard Reply Delay: 1.5 to 6.0 microseconds, adjustable

3.1.5 Interrogation Pulse Coding: Single or double pulse, selectable

3.1.6 Pulse Repetition Frequency Response Range: 0 to 3000 pps

3.1.7 Recovery Time: 50 microseconds maximum

3.1.8 Nominal Operating Voltage: 21 to 31 Vdc

3.1.9 Operating Stabilization time: 180 seconds

3.2 **Receiver/Decoder Characteristics**

3.2.1 Design Type: Superheterodyne

3.2.2 Frequency Range: 9.0 to 9.5 GHz

3.2.3 Receiver Tuning: Single local oscillator tuning control and three preselector tuning controls accessible from exterior of unit

3.2.4 Frequency Stability: ±2 MHz

3.2.5 3 dB Bandwidth: 11 ±3 MHz

3.2.6 40 dB Bandwidth: 90 MHz typical

3.2.7 Off-Frequency and Image Rejection: Image Rejection 60 dB minimum

3.2.8 Dynamic Signal Range: 0 to -65 dBm

3.2.9 Maximum Input Signal: +20 dBm

3.2.10 Pulse Width Acceptance: 1.0 ±0.2 microsecond, single pulse. 0.25 to 0.5 microsecond, double pulse

3.2.11 Pulse Rise Time Acceptance: 0.1 microsecond or less

3.2.12 Pulse Code Spacing: 3.0 to 12.0 microseconds, adjustable

3.2.13 Decoder Accept Limits: ±0.15 microsecond

3.2.14 Decoder Reject Limits: ±0.30 microsecond

3.2.15 Delay Decision Pulse Trigger Point (Percent of rise time): Not specified

3.3 **Transmitter Characteristics**

3.3.1 Design Type: Magnetron

3.3.2 Frequency Range: 9.2 to 9.5 GHz

3.3.3 Transmitter Tuning: Single Control accessible from exterior of unit

3.3.4 Frequency Stability: ±2.5 MHz under all conditions

3.3.5 Peak Power Output: 300 watts minimum

3.3.6 Power Spectrum: The RF bandwidth in MHz will not exceed 3.0/pulse width in microseconds measured at the quarter power point.

3.3.7 Spectral Purity: Not specified

3.3.8 Spurious Radiation: Not specified

3.3.9 Pulse Repetition Rate Range: 0 to 3000 pulses per second

3.3.10 Duty Cycle: 0.002 maximum

3.3.11 Pulse Width: 0.5 ±0.1 microsecond

3.3.12 Pulse Width Jitter: Not specified

3.3.13 Pulse Amplitude Variation: Not specified

3.3.14 Pulse Rise Time (10 to 90 percent): 0.1 microsecond maximum

3.3.15 Pulse Fall Time (90 to 10 percent): 0.2 microsecond maximum

3.4 **Delay Characteristics**

3.4.1 Absolute System Delay Variation: Not specified

3.4.2 Reply Delay Variations

3.4.2.1 Signal Strength Variation: ±0.05 microsecond from 0 to -63 dBm

3.4.2.2 Interrogation Rate Variation: Not specified

3.4.2.3 Interrogation Frequency Variation: Not specified

3.4.2.4 Pulse Code Spacing Variation: Not specified

3.4.2.5 Decision Pulse Rise Time Variation: Not specified

3.4.2.6 Input Power Potential Variation: Not specified

3.4.2.7 Acceleration Variation: Not specified

3.4.3 Reply Delay Jitter: ±0.05 microsecond at an input signal level of -55 to -63 dBm. ±0.02 microsecond at input signal level of 0 to -55 dBm.

3.5 **Radio Frequency Load Matching Characteristics**

3.5.1 Input Impedance: 50 ohm nominal

3.5.2 Output Impedance: 50 ohm nominal

3.5.3 Open/Short Survival: Transmitter shall meet all requirements after application and removal of either a short or open circuit at the antenna terminal.

3.5.4 Voltage Standing Wave Ratio of Load: Will operate in conjunction with an antenna system having a VSWR of 2:1 at all phase angles.

3.5.5 Duplexer Type: Four-port ferrite circulator

3.6 **Power Supply Characteristics**

3.6.1 Design Type: Primary regulated dc-dc converter

3.6.2 Input Voltage Range: 21 to 31 Vdc

3.6.3 Under Voltage/Over Voltage Protection: Not specified

3.6.4 Input Current, Quiescent: 1.0 ampere maximum

3.6.5 Input Current, Interrogated at 3000 pulses per second: 1.5 ampere maximum

3.6.6 Transient Protection: MIL-STD-704 (tailored)

3.6.7 Grounding and Isolation: Input power lines isolated from chassis ground

3.6.8 Standby Operation: Same as quiescent

3.7 **Design Characteristics**

3.7.1 Response to Valid Interrogations: Shall trigger at least 99 percent replies to signals at level between 0 to -65 dBm applied to the transponder antenna connector

3.7.2 Random Triggering: Will not exceed 10 pulses per minute averaged over a 10 minute interval.

3.7.3 Transmitter-Receiver Frequency Separation: 50 MHz minimum

3.7.4 Off-Band Rejection Filter: Three section preselector and tuned IF amplifier

3.7.5 Mixer Diode Protection: Preselector protects diode from off frequency RF.

3.7.6 Power Delay Time: 180 seconds

3.7.7 Reverse Polarity Protection: Provided on 28 Vdc line

3.7.8 Over-Interrogation Protection: Provided to limit transmitter duty cycle to 0.002

3.7.9 Lock-Out Protection: Provides for no response during 50 microsecond recovery time of transponder

3.8 **Environmental Specifications**

3.8.1 Operating Temperature: -54°C to +71°C (-65°F to +160°F)

3.8.2 Nonoperating Temperature: -62°C to +85°C(-80°F to +185°F)

3.8.3 Pressure Altitude: 100,000 feet

3.8.4 Shock: 18 half sine impact shocks of 100g consisting of 3 shocks in opposite directions along each of 3 mutually perpendicular axes, each shock impulse having a time duration of 11 milliseconds.

3.8.5 Sine Vibration: MIL-E-5400T, figure 2, curve IVa, 3 axes. Logarithmic sweep 5-2000-5 Hz in 20 minutes, 10g level. Total vibration 1 hour per axis.

3.8.6 Random Vibration: Not specified

3.8.7 Acoustical Noise: Not specified

3.8.8 Random Noise: Not specified

3.8.9 Acceleration: Not specified

3.8.10 Humidity: Not specified (will withstand submergence in 3 feet of water for 1 hour without water intrusion)

3.8.11 Salt Fog Atmosphere: Not specified (The transponders exterior surfaces show no signs of corrosion after emersion in sea water.)

3.8.12 Rain: Not specified (will withstand submersion in 3 feet of water for 1 hour without water intrusion)

3.8.13 Sand and Dust: Not specified

3.8.14 Fungus: Not specified

3.8.15 Missile Fuel Compatibility: Not specified

3.8.16 Electromagnetic Compatibility: MIL-STD-461B, Class A1, Methods CE03, RE03, CS01, CS02, CS06, RE02, and RS03

3.9 **Physical/Mechanical Characteristics**

3.9.1 Form: Rectangular Solid

3.9.2 Dimensions, Excluding Protrusions: 4.27 x 4.68 x 2.26 inches

3.9.3 Displacement Volume: 43 cubic inches

3.9.4 Weight: 45 ounces maximum

3.9.5 Pressurization: 16.0 ±0.5 pounds per square inch maximum

3.9.6 Mounting Attitude: Any

3.9.7 Mounting Dimensions: 6 holes 0.173 diameter, 1 hole on centerline front and rear spaced 4.69 inches apart. 1 hole 1.84 inches either side of centerline front and rear.

3.9.8 Power and Test Connector: MS3114H8C-4P (mates with MS3116E8-4S)

3.9.9 Radio Frequency Connector: TNC female

3.9.10 Type of External Controls: None

3.9.11 Pressurization Fitting Type: Schraeder type with protective cap

3.9.12 Grounding and Bonding: Not necessary

3.9.13 Mounting Bracket: Not specified

3.9.14 Mounting Type: Not specified

3.10 **Auxiliary Functions**

3.10.1 External Output Signal Provisions: Not specified

3.10.2 External Input Signal Provisions: Not specified

3.10.3 External Adjustments: Transmitter tuning, receiver tuning, sensitivity, decoder, delay and transmitter pulse width

3.10.4 External Test Points: Not specified

3.10.5 Internal Test Points: Provided to allow rapid isolation of malfunction to a particular module

3.11 **Coherent Velocity Specifications**

3.11.1 Pulse Coherence Doppler Error: Not applicable

3.11.2 Dynamic Signal Strength Range: Not applicable

3.11.3 Spectral Skew: Not applicable

3.11.4 Carrier Line Width: Not applicable

3.11.5 Interline Noise: Not applicable

3.11.6 Frequency Locking Range: Not applicable

4.0 **QUALITY/RELIABILITY DATA**

4.1 **Reliability Characteristics**

4.1.1 Design Reliability: Lower test mean time between failure (MTBF) of 50 hours and an upper test MTBF of 100 hours when tested in accordance with MIL-STD-781

4.1.2 Operational Stability: 25 hours without adjustment

4.1.3 Service Life: 1000 hours minimum with minimal servicing and replacement of parts

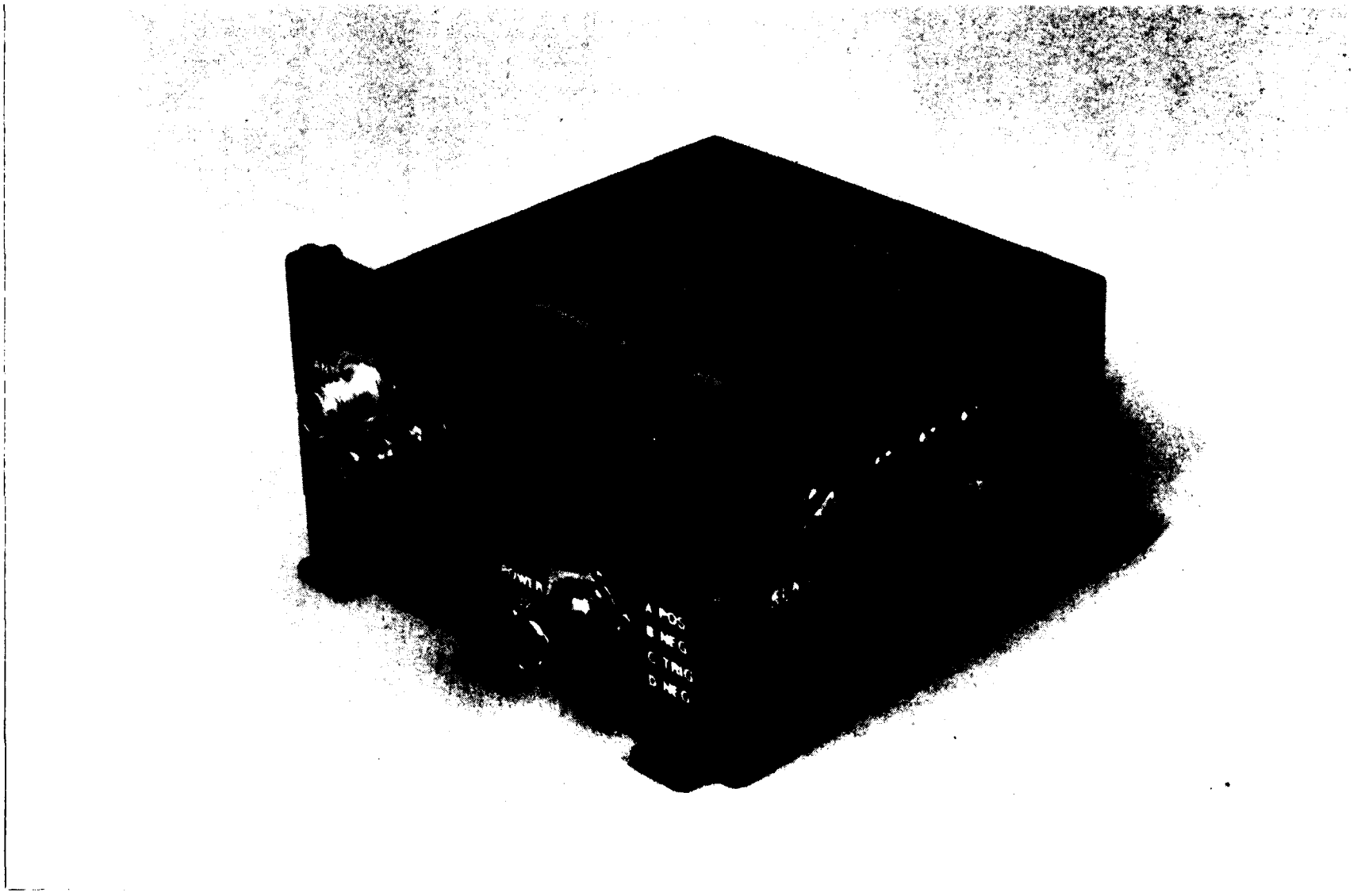

Figure 3-3. Model 380X I-Band Radar Transponder.

4. HERLEY INDUSTRIES, INC.
10 INDUSTRY DRIVE
LANCASTER, PENNSYLVANIA
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X-BAND RADAR TRACKING TRANSPONDERS

Model MD400X-1

HERLEY INDUSTRIES, INC.
X-BAND RADAR TRACKING TRANSPONDER

Manufacturer's Model Designation:	**MD400X-1**
Manufacturer's Part Number:	**500004-1**
Military Designation:	**None**
Federal Stock Number:	**None**

1.0 GENERAL DESCRIPTION

The model MD400X-1 is a general purpose, precision X-band radar augmentation device with a high sensitivity superheterodyne receiver and magnetron transmitter. Used primarily for range safety functions, the model MD400X is suitable for use in both manned and unmanned vehicles. This transponder is applicable to precision tracking of aircraft, sounding rockets, space-launch vehicles, missiles, and target drones, both sea and airborne. This unit is fully tuneable over the 9.0 to 9.5 GHz range, while being quite small (less than 45 cubic inches) and lightweight (less than 45 ounces), making it suitable for use in applications requiring small size with high power. Environmental requirements are to MIL-STD-810.

2.0 DEVELOPMENT AND UTILIZATION

The model MD400X-1 was developed by Herley Industries, Inc. with company funds to fill the need for a rugged, precision radar transponder, whose modern circuitry greatly improves reliability and performance. The model MD400C-1 is a family of transponders with many minor variations to suit each customer's unique system requirements. The model MD400C-1 has been qualified by the Naval Air Warfare Center Weapons Division (NAWCWPNS), Point Mugu, California. It is being used on such programs as Harpoon and SLAM, range aircraft at various facilities, and target and missile applications at NAWCWPNS, Point Mugu.

3.0 TECHNICAL SPECIFICATIONS

3.1 General Characteristics

3.1.1 Frequency Range: 9.0 to 9.5 GHz

3.1.2 Trigger Sensitivity: -70 dBm minimum for 99 percent reply

3.1.3 Peak Power Output: 400 watts minimum

3.1.4 Standard Reply Delay: Adjustable from 1.5 to 6.0 microseconds

3.1.5 Interrogation Pulse Coding: 3.0 to 12.0 microseconds

3.1.6 Pulse Repetition Frequency Response Range: 100 to 3000 pps nominal

3.1.7 Recovery Time: 50 microseconds maximum

3.1.8 Nominal Operating Voltage: 22 to 32 Vdc

3.1.9 Operating Stabilization Time: 3 minutes maximum

3.2 **Receiver/Decoder Characteristics**

3.2.1 Design Type: Superheterodyne

3.2.2 Frequency Range: 9.0 to 9.5 GHz

3.2.3 Receiver Tuning: Mechanical (4 screws)

3.2.4 Frequency Stability: ±3.0 MHz after a 3 minute warmup

3.2.5 3 dB Bandwidth: 11.0 ±3.0 MHz

3.2.6 40 dB Bandwidth: Not specified

3.2.7 Off-Frequency and Image Rejection: 60 dB minimum

3.2.8 Dynamic Signal Range: +20 to -70 dBm

3.2.9 Maximum Input Signal: +20 dBm

3.2.10 Pulse Width Acceptance: 0.25 to 5.0 microseconds in single pulse mode, 0.25 to 1.0 microsecond in the double pulse mode

3.2.11 Pulse Rise Time Acceptance: 0.100 microsecond maximum

3.2.12 Pulse Code Spacing Range: 3.0 to 12.0 microseconds

3.2.13 Decoder Accept Limits: ±0.150 microsecond

3.2.14 Decoder Reject Limits: ±0.300 microsecond

3.2.15 Delay Decision Pulse Trigger Point (Percent of rise time): 50 percent

3.3 **Transmitter Characteristics**

3.3.1 Design Type: Magnetron

3.3.2 Frequency Range: 9.0 to 9.5 GHz

3.3.3 Transmitter Tuning: Mechanical (1 screw)

3.3.4 Frequency Stability: ±3.0 MHz ±50 KHz/°C maximum

3.3.5 Peak Power Output: 400 watts minimum

3.3.6 Power Spectrum: Bandwidth (MHz) is less than 3.0/pulse width (in microseconds) measured at the 1/4 power level points.

3.3.7 Spectral Purity: First side lobes 7 dB below peak main lobe minimum. First nulls 9 dB below peak main lobe minimum.

3.3.8 Spurious Radiation: Not specified

3.3.9 Pulse Repetition Rate Range: 100 to 3000 pps

3.3.10 Duty Cycle: Up to 0.002 (0.2 percent)

3.3.11 Pulse Width: 0.5 ±0.1 microsecond

3.3.12 Pulse Width Jitter: 0.01 microsecond maximum

3.3.13 Pulse Amplitude Variation: Not specified

3.3.14 Pulse Rise Time: 0.100 microsecond maximum

3.3.15 Pulse Fall Time: 0.200 microsecond maximum

3.4 **Delay Characteristics**

3.4.1 Absolute System Delay Variation: Not specified

3.4.2 Reply Delay Variations

3.4.2.1 Signal Strength Variation: 0.03 microsecond maximum for input signals between 0 and -60 dBm

3.4.2.2 Interrogation Rate Variation: 0.016 microsecond maximum for prf from 160 to 2600 pps

3.4.2.3 Interrogation Frequency Variation: 0.01 microsecond typical for ±3.0 MHz

3.4.2.4 Pulse Code Spacing Variation: 0.05 microsecond typical for code space variations of ±0.15 microsecond

3.4.2.5 Decision Pulse Rise Time Variation: 0.02 microsecond maximum

3.4.2.6 Input Power Potential Variation: 0.01 microsecond maximum

3.4.2.7 Temperature Variation: 0.01 microsecond maximum from a nominal delay at 80.6°F (27°C) and 0 dBm input for temperatures ranging from -18°F (-28°C) to +156°F (+69°C) and 0.02 microsecond maximum for temperatures ranging from -65.2°F (-54°C) to +185°F (+85°C)

3.4.2.8 Acceleration Variation: Not specified

3.4.3 Reply Delay Jitter: 0.02 microsecond maximum peak to peak for 0 dBm to -55 dBm, and 0.05 microsecond maximum peak to peak for -55 dBm to -65 dBm

3.5 **Radio Frequency Load Matching Characteristics**

3.5.1 Input Impedance: 50 ohm

3.5.2 Output Impedance: 50 ohm

3.5.3 Open-Short Survival: Built in to provide antenna mismatch protection

3.5.4 Voltage Standing Wave Ratio of the Load: 2:1 maximum

3.5.5 Duplexer Type: Four-port circulator

3.6 **Power Supply Characteristics**

3.6.1 Design Type: Series pass regulator with chopper

3.6.2 Input Voltage Range: 22 to 32 Vdc

3.6.3 Under Voltage/Over Voltage Protection: Normal regulation to 20.5 volts input/higher voltage components used

3.6.4 Input Current, Quiescent: 0.60 amp maximum

3.6.5 Input Current, Interrogated at 1000 pps: 1.10 amp (0.70 amp typical)

3.6.6 Transient Protection: Provided by regulator portion of power supply

3.6.7 Grounding and Isolation: Power leads isolated from chassis by 1 meg ohm minimum

3.6.8 Standby Operation: None

3.7 **Design Characteristics**

3.7.1 Response to Valid Interrogation: Better than 99 percent for all valid interrogations

3.7.2 Random Triggering and Free Running: Less than 10 pps under all conditions

3.7.3 Transmitter-Receiver Frequency Separation: 50 MHz minimum

3.7.4 Off-Band Rejection Filter: Provided with the three section preselector

3.7.5 Mixer Diode Protection: Limited to +20 dBm input

3.7.6 Power Delay Time: 45 seconds nominal

3.7.7 Reverse Polarity Protection: Provided with series diode

3.7.8 Over-Interrogation Protection: Provided with internal integrator circuit

3.7.9 Lock-Out Protection: Receiver blanked for 50 micro-seconds maximum during transmit time

3.8 **Environmental Specifications**

3.8.1 Operating Temperature: -54°C (-66°F) to +75°C (+167°F)

3.8.2 Nonoperating Temperature: -62.2°C (-80°F) to +75°C (+167°F)

3.8.3 Pressure Altitude: 760 mm of mercury (sea level) to 0.04 mm of mercury (230,000 feet altitude)

3.8.4 Shock: 100g sawtooth for 6 milliseconds duration, operating

3.8.5 Sine Vibration: 5 to 10 Hz, 0.20 inch double amplitude; 10 to 18 Hz, 1g; 18 to 81 Hz, 0.06 inch double amplitude; 81 to 2000 Hz, 20g

3.8.6 Random Vibration: $0.0008g^2$ rms/Hz at 20 Hz, increasing at 6 dB/octave, to $0.20g^2$ rms/Hz at 100 Hz; 16.9g rms from 100 to 1000 Hz; decreasing at 6 dB/octave from $0.20g^2$ rms/Hz at 1000 Hz, to $0.05g^2$ rms/Hz at 2000 Hz

3.8.7 Acoustical Noise: Not specified

3.8.8 Random Noise: Not specified

3.8.9 Acceleration: 30g applied along any axis for 1 minute

3.8.10 Humidity: Any, up to 100 percent including condensation because of temperature changes

3.8.11 Salt Fog Atmosphere: Not specified

3.8.12 Rain: Not specified

3.8.13 Sand and Dust: Not specified

3.8.14 Fungus: Not specified

3.8.15 Missile Fuel Compatibility: Not specified

3.8.16 Electromagnetic Interference: Methods CE03, CE06, CE07, CS01, CS02, CS06, RE02, RS02, and RS03 of MIL-STD 461

3.9 **Physical/Mechanical Characteristics**

3.9.1 Form: Rectangular

3.9.2 Dimensions, Excluding Protrusions: 5.00L X 4.68W X 2.53H (12.70 X 11.89 X 6.43 cm)

3.9.3 Displacement Volume: 45 cubic inches (738 cubic cm) nominal

3.9.4 Weight: 45 ounces (1.28 kgm) maximum

3.9.5 Pressurization: Sealed at sea level

3.9.6 Mounting Attitude: Any

3.9.7 Mounting Dimensions: 6 holes, 3 in each line spaced 1.843 inch to either side of the center, with the lines separated by 4.687 inches. Clearance holes for #6 screws.

3.9.8 Power and Test Connector Type: MS3114H8-4P (mates with PT06E8-4S or MS3116E8-6S)

3.9.9 Radio Frequency Connector Type: TNC female

3.9.10 Type of External Controls: Slotted screwdriver adjust with removal of a seal screw

3.9.11 Pressurization Fitting Type: Schraeder valve mounted on unit

3.9.12 Grounding and Bonding: Entire case at ground potential

3.9.13 Mounting Bracket: None

3.9.14 Mounting Type: Provision for six #6 screws

3.10 **Auxiliary Functions**

3.10.1 External Output Signal Provisions: None

3.10.2 External Input Signal Provisions: None

3.10.3 External Adjustments: Receiver tune, transmitter tune (provided with removal of seal screws)

3.10.4 External Test Points: None

3.10.5 Internal Test Points: Provided for easy signal tracing

3.11 **Coherent Velocity Specifications**

3.11.1 Pulse Coherence Doppler Error: Not applicable

3.11.2 Dynamic Signal Strength Range: Not applicable

3.11.3 Spectral Skew: Not applicable

3.11.4 Carrier Line Width: Not applicable

3.11.5 Interline Noise: Not applicable

3.11.6 Frequency Locking Range: Not applicable

4.0 **QUALITY/RELIABILITY DATA**

4.1 **Reliability Characteristics**

4.1.1 Design Reliability: The mean time between failures (MTBF) has been tested to greater than 30 hours at a 90 percent confidence level

4.1.2 Operational Stability: Not specified

4.1.3 Service Life: Not specified

HERLEY INDUSTRIES, INC.
X-BAND RADAR TRACKING TRANSPONDER

Manufacturer's Model Designation:	**MD400X-1**
Manufacturer's Part Number:	**500004-3**
Military Designation:	**AN/DPN-90(V)2**
Military Part Number:	**1356AS3020-2**
Temporary Federal Stock Number:	**LLWY60837**
Permanent Federal Stock Number:	**7RH 1420-01-342-1534**

1.0 GENERAL DESCRIPTION

The model MD400X-1 is a general purpose, precision X-band radar augmentation device with a high sensitivity superheterodyne receiver and magnetron transmitter. Used primarily for range safety functions, the model MD400X is suitable for use in both manned and unmanned vehicles. This transponder is applicable to precision tracking of aircraft, sounding rockets, space-launch vehicles, missiles, and target drones, both sea and airborne. This unit is fully tuneable over the 9.0 to 9.5 GHz range, while being quite small (less than 45 cubic inches) and lightweight (less than 45 ounces), making it suitable for use in applications requiring small size with high power. The model MD400X-1, P/N 500004-3 has been designated by the U.S. Navy as the AN/DPN-90(V)2, P/N 1356AS3020-2. It meets the requirements of specification MIL-T-85678(AS) with regard to performance and environmental conditions.

2.0 DEVELOPMENT AND UTILIZATION

The model MD400X-1 was developed by Herley Industries, Inc. to fill the need for a rugged, precision radar transponder, whose modern circuitry greatly improves reliability and performance. The AN/DPN-90(V)2 version of the model MD400X-1 is a family of transponders with many minor variations to suit each customer's unique system requirements. The AN/DPN-90(V)2 has been qualified by the U.S. Navy Naval Air Warfare Center Weapons Division (NAWCWPNS), Point Mugu, California, (formerly Pacific Missile Test Center). It is being used on numerous target and missile applications.

3.0 TECHNICAL SPECIFICATIONS

3.1 General Characteristics

3.1.1 Frequency Range: 9.0 to 9.5 GHz

3.1.2 Trigger Sensitivity: -70 dBm minimum for 99 percent reply

3.1.3 Peak Power Output: 300 watts minimum (400 watts typical minimum)

3.1.4 Standard Reply Delay: Adjustable from 1.5 to 6.0 microseconds

3.1.5 Interrogation Pulse Coding: 3.0 to 12.0 microseconds

3.1.6 Pulse Repetition Frequency Response Range: 100 to 3000 pps nominal

3.1.7 Recovery Time: 50 microseconds maximum

3.1.8 Nominal Operating Voltage: 21 to 31 Vdc

3.1.9 Operating Stabilization Time: 3 minutes maximum

3.2 Receiver/Decoder Characteristics

3.2.1 Design Type: Superheterodyne

3.2.2 Frequency Range: 9.0 to 9.5 GHz

3.2.3 Receiver Tuning: Mechanical (4 screws)

3.2.4 Frequency Stability: ±2.0 MHz after a 3 minute warmup

3.2.5 3 dB Bandwidth: 11.0 ±3.0 MHz

3.2.6 40 dB Bandwidth: Not specified

3.2.7 Off-Frequency and Image Rejection: 60 dB minimum

3.2.8 Dynamic Signal Range: +20 to -70 dBm

3.2.9 Maximum Input Signal: +20 dBm

3.2.10 Pulse Width Acceptance: 0.25 to 1.0 microsecond in single pulse mode, 0.25 to 0.5 microsecond in the double pulse mode

3.2.11 Pulse Rise Time Acceptance: 0.100 microsecond maximum

3.2.12 Pulse Code Spacing Range: 3.0 to 12.0 microseconds

3.2.13 Decoder Accept Limits: ±0.150 microsecond

3.2.14 Decoder Reject Limits: ±0.300 microsecond

3.2.15 Delay Decision Pulse Trigger Point (Percent of rise time): Not specified

3.3 **Transmitter Characteristics**

3.3.1 Design Type: Magnetron

3.3.2 Frequency Range: 9.2 to 9.5 GHz

3.3.3 Transmitter Tuning: Mechanical (1 screw)

3.3.4 Frequency Stability: ±5.0 MHz under all conditions (±3.0 MHz typical)

3.3.5 Peak Power Output: 300 watts minimum (400 watts typical)

3.3.6 Power Spectrum: Not specified

3.3.7 Spectral Purity: Not specified

3.3.8 Spurious Radiation: Not specified

3.3.9 Pulse Repetition Rate Range: 100 to 3000 pps

3.3.10 Duty Cycle: Not specified

3.3.11 Pulse Width: 0.5 ±0.1 microsecond

3.3.12 Pulse Width Jitter: Not specified

3.3.13 Pulse Amplitude Variation: Not specified

3.3.14 Pulse Rise Time: 0.100 microsecond maximum

3.3.15 Pulse Fall Time: 0.200 microsecond maximum

3.4 **Delay Characteristics**

3.4.1 Absolute System Delay Variation: Not specified

3.4.2 Reply Delay Variations

3.4.2.1 Signal Strength Variation: ±0.05 microsecond maximum for input signals between 0 and -63 dBm. ±0.30 microsecond typical

3.4.2.2 Interrogation Rate Variation: Not specified

3.4.2.3 Interrogation Frequency Variation: Not specified

3.4.2.4 Pulse Code Spacing Variation: Not specified

3.4.2.5 Decision Pulse Rise Time Variation: Not specified

3.4.2.6 Input Power Potential Variation: Not specified

3.4.2.7 Temperature Variation: Not specified

3.4.2.8 Acceleration Variation: Not specified

3.4.3 Reply Delay Jitter: ±0.02 microsecond maximum for 0 dBm to -55 dBm, and ±0.05 microsecond maximum for -55 dBm to -65 dBm

3.5 **Radio Frequency Load Matching Characteristics**

3.5.1 Input Impedance: 50 ohm

3.5.2 Output Impedance: 50 ohm

3.5.3 Open-Short Survival: Built in to provide antenna mismatch protection

3.5.4 Voltage Standing Wave Ratio of the Load: 2:1 maximum

3.5.5 Duplexer Type: Four-port circulator

3.6 **Power Supply Characteristics**

3.6.1 Design Type: Switching mode regulator with non-saturating chopper

3.6.2 Input Voltage Range: 21 to 31 Vdc

3.6.3 Under Voltage/Over Voltage Protection: Normal regulation to 20.5 volts input/higher voltage components used

3.6.4 Input Current, Quiescent: 1.0 amp maximum (0.5 amp typical)

3.6.5 Input Current, Interrogated at 1000 pps: 1.1 amp maximum (0.7 amp typical)

3.6.6 Transient Protection: Provided by regulator portion of power supply

3.6.7 Grounding and Isolation: Power leads isolated from chassis by 1 meg ohm minimum

3.6.8 Standby Operation: None

3.7 **Design Characteristics**

3.7.1 Response to Valid Interrogation: Better than 99 percent for all valid interrogations

3.7.2 Random Triggering and Free Running: Less than 10 ppm under all conditions

3.7.3 Transmitter-Receiver Frequency Separation: 50 MHz minimum

3.7.4 Off-Band Rejection Filter: Provided with the three section preselector

3.7.5 Mixer Diode Protection: Limited to +20 dBm input

3.7.6 Power Delay Time: 45 seconds nominal

3.7.7 Reverse Polarity Protection: Provided with series diode

3.7.8 Over-Interrogation Protection: Provided with internal integrator circuit

3.7.9 Lock-Out Protection: Receiver blanked for 50 microseconds maximum during transmit time

3.8 **Environmental Specifications**

3.8.1 Operating Temperature: -54°C (-66°F) to +71°C (+160°F)

3.8.2 Nonoperating Temperature: -62.2°C (-80°F) to +95°C (+203°F)

3.8.3 Pressure Altitude: 760 mm of mercury (sea level) to 8.00 mm of mercury (100,000 feet altitude)

3.8.4 Shock: 100g sawtooth for 11 milliseconds duration, operating

3.8.5 Sine Vibration: 5 to 14 Hz, 0.10 inch double amplitude; 14 to 23 Hz, 1g; 23 to 74 Hz, 0.036 inch double amplitude; 74 to 2000 Hz, 10g, unit operating

3.8.6 Random Vibration: Not specified

3.8.7 Acoustical Noise: Not specified

3.8.8 Random Noise: Not specified

3.8.9 Acceleration: Not specified

3.8.10 Humidity: Up to 95 percent at 65°C for 6 hours for 3 cycles

3.8.11 Salt Fog Atmosphere: Not specified

3.8.12 Rain: Not specified

3.8.13 Sand and Dust: Not specified

3.8.14 Fungus: Not specified

3.8.15 Missile Fuel Compatibility: Not specified

3.8.16 Electromagnetic Interference: Methods CE03, CE07, CS01, CS02, CS06, RE02, RS02, and RS03 of MIL-STD 461

3.9 **Physical/Mechanical Characteristics**

3.9.1 Form: Rectangular

3.9.2 Dimensions, Excluding Protrusions: 5.00L X 4.68W X 2.53H (12.70 X 11.89 X 6.43 cm)

3.9.3 Displacement Volume: 45 cubic inches (738 cubic cm) nominal

3.9.4 Weight: 45 ounces (1.28 kgm) maximum

3.9.5 Pressurization: Sealed at sea level

3.9.6 Mounting Attitude: Any

3.9.7 Mounting Dimensions: 6 holes, 3 in each line spaced 1.843 inch to either side of the center, with the lines separated by 4.687 inches. Clearance holes for #6 screws.

3.9.8 Power and Test Connector Type: MS3114H8-4P (mates with PT06E8-4S or MS3116E8-6S)

3.9.9 Radio Frequency Connector Type: TNC female

3.9.10 Type of External Controls: Slotted screwdriver adjust with removal of a seal screw

3.9.11 Pressurization Fitting Type: Schraeder valve mounted on unit

3.9.12 Grounding and Bonding: Entire case at ground potential

3.9.13 Mounting Bracket: None

3.9.14 Mounting Type: Provision for six #6 screws

3.10 **Auxiliary Functions**

3.10.1 External Output Signal Provisions: None

3.10.2 External Input Signal Provisions: None

3.10.3 External Adjustments: Receiver tune, transmitter tune (provided with removal of seal screws)

3.10.4 External Test Points: None

3.10.5 Internal Test Points: Provided for easy signal tracing

3.11 **Coherent Velocity Specifications**

3.11.1 Pulse Coherence Doppler Error: Not applicable

3.11.2 Dynamic Signal Strength Range: Not applicable

3.11.3 Spectral Skew: Not applicable

3.11.4 Carrier Line Width: Not applicable

3.11.5 Interline Noise: Not applicable

3.11.6 Frequency Locking Range: Not applicable

4.0 **QUALITY/RELIABILITY DATA**

4.1 **Reliability Characteristics**

4.1.1 Design Reliability: The mean time between failures (MTBF) has been tested to greater than 50 hours at a 90 percent confidence level

4.1.2 Operational Stability: Not specified

4.1.3 Service Life: Not specified

HERLEY INDUSTRIES, INC.
X-BAND RADAR TRACKING TRANSPONDER

Manufacturer's Model Designation:	**MD400X-1**
Manufacturer's Part Number:	**500004-4**
Military Designation:	**None**
Military Part Number:	**642AS8982-3**
Federal Stock Number:	**None**

1.0 GENERAL DESCRIPTION

The model MD400X-1 is a general purpose, precision X-band radar augmentation device with a high sensitivity superheterodyne receiver and magnetron transmitter. Used primarily for range safety functions, the model MD400X is suitable for use in both manned and unmanned vehicles. This transponder is applicable to precision tracking of aircraft, sounding rockets, space-launch vehicles, missiles, and target drones, both sea and airborne. This unit is fully tuneable over the 9.0 to 9.5 GHz range, while being quite small (less than 45 cubic inches) and lightweight (less than 45 ounces), making it suitable for use in applications requiring small size with high power. The MD400X-1, P/N 500004-3 has been designated by the U.S. Navy as the AN/DPN-90(V)2. It meets the requirements of specification MIL-T-85678(AS) with regard to performance and environmental conditions. The 500004-4 meets or exceeds these requirements.

2.0 DEVELOPMENT AND UTILIZATION

The model MD400X-1 was developed by Herley Industries, Inc. to fill the need for a rugged, precision radar transponder, whose modern circuitry greatly improves reliability and performance. The AN/DPN-90(V)2 version of the model MD400X-1 is a family of transponders with many minor variations to suit each customer's unique system requirements. The AN/DPN-90(V)2 has been qualified by the U.S. Navy Naval Air Warfare Center Weapons Division (NAWCWPNS), Point Mugu, California, (formerly Pacific Missile Test Center). It is being used on numerous target and missile applications. The 500004-4 version has been qualified by McDonnell Douglas Missile Systems Company for use on the Harpoon and SLAM missile programs.

3.0 TECHNICAL SPECIFICATIONS

The 500004-4 is the same unit as the U.S. Navy AN/DPN-90(V)2 with the exception of a change in the power connector to a MS27478Y10098P. The unit has also been tested to higher levels of vibration, shock, acceleration, and temperature, and additional EMI tests (CE01, CE06, CS03, CS04, and CS05) were also satisfied.